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Dayton Aircraft Cabin Fire Model, Version 3, Volume II - Program User's Guide and Appendices

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June 1982

Final Report

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16. Abstract

Version 3 of the Dayton Aircraft Cabin Fire Model (DACFIR) has been created as a refinement and generalization of earlier mathematical models for the computer simulation of fire growth in the cabin of a commercial transport airplane. The model uses data from laboratory tests on the cabin furnishing materials and a zone (control volume) representation of the cabin atmosphere to predict the accumulation of heat, smoke, and gases resulting from arbitrary ignition sources specified in the program input. The major improvements included in Version 3 are a revised cabin atmosphere model which allows for multiple compartments and the prescribed entry of exterior fire gases, and an implicit numerical integration technique for the atmosphere equations. Volume I of this report contains a full description of the model's predictions to the results of three full-scale cabin fire tests. Volume II consists of appendices which include a user's guide and listing of the computer code.

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PREFACE

This report was prepared by the University of Dayton Research Institute for the Federal Aviation Administration Technical Center under Contract FA74WA-3532 during the period April 1980 through March 1981. The report describes the third refined version of the Dayton Aircraft Cabin Fire Model (DACFIR).

Work was performed at the University of Dayton under the supervision of Nicholas Engler. Others at the University who contributed to this program are John Myers, Steven Vondrell, Thomas Shirley, and Zalfa Abdelnour. Much of the original development of the DACFIR model is due to Jerry Reeves, Peter Kahut, and James Luers. The author wishes to thank Gretchen Walther, Jacquelin Aldrich, and Pamela Ecker for their assistance in preparing this report.

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SECTION 1

INTRODUCTION

This volume contains a description and guide for the use of the Dayton Aircraft Cabin Fire simulation program (DACFIR3). DACFIR3 differs substantially from earlier versions of the DACFIR program. User's guides for earlier versions were given in Volume III of reference 1 and Appendix C of reference 2. While this volume draws from material presented in the earlier volumes, familiarity with Versions 1 and 2 of DACFIR is not necessary for the use of the present version. The intent of this user's guide is to provide instruction for the efficient use of DACFIR3, but not to present the construction of the computer code in detail. The guide provides an annotated flow chart of the main controlling program, instructions for preparing the input data, sample input and output, program statistical data, and a listing of the computer code. The code listing, given in Appendix A, contains a large number of comment statements which provide a line-by-line description of the operation of the program.

1.1 DEFINITIONS AND CONVENTIONS

In the DACFIR program, the cabin may consist of one to four compartments, each of identical cross section, which are assumed to be connected end to end. The interior of each compartment consists of from six to 22 horizontal and vertical surfaces. Two of these surfaces are the partitions which divide the cabin fore and aft to form the compartment. The remaining four to 20 surfaces are parallel to the cabin fore-aft direction and represent the floor, sidewalls, hatracks, stowbins, passenger service units (PSU's), and ceilings. One of the compartments contains the "detailed section" defined as the portion of the interior where the element grid scheme is applied. Within this detailed section the user may specify the dimensions and locations of from one to nine seat groups (rows). The surface of each seat group is divided into elements of the same size as those on the cabin lining surfaces.

Each surface and seat group is identified by a single number and each element by a pair of numbers, the element i and j indices. Assignment of the surface and seat numbers and element indices is made by the program based upon the values and order of the input data. The conventions and assumptions to be noted in preparing input are as follows:

(1) All cabin lining surfaces, with the exception of the partitions, are assumed to be parallel to the cabin y-axis (fore-aft direction.) (See Figure 1 of this volume and Figure 6 of Volume I.) Each surface is either parallel or perpendicular to the x-y (floor) plane, and all surfaces extend over the full length of the detailed section. The seat group configuration consists of fixed dimensions as shown in Figure 6, Volume I. All seats must face forward.

(2) Numbering of the cabin lining surfaces starts with the floor, surface number one, and proceeds counterclockwise (to a viewer facing aft) up the sidewall, across the ceiling, and down the opposite sidewall to return to the floor. This scheme is shown in Figure 1 for a cabin arrangement with shelf-like hatracks and a three part sidewall.

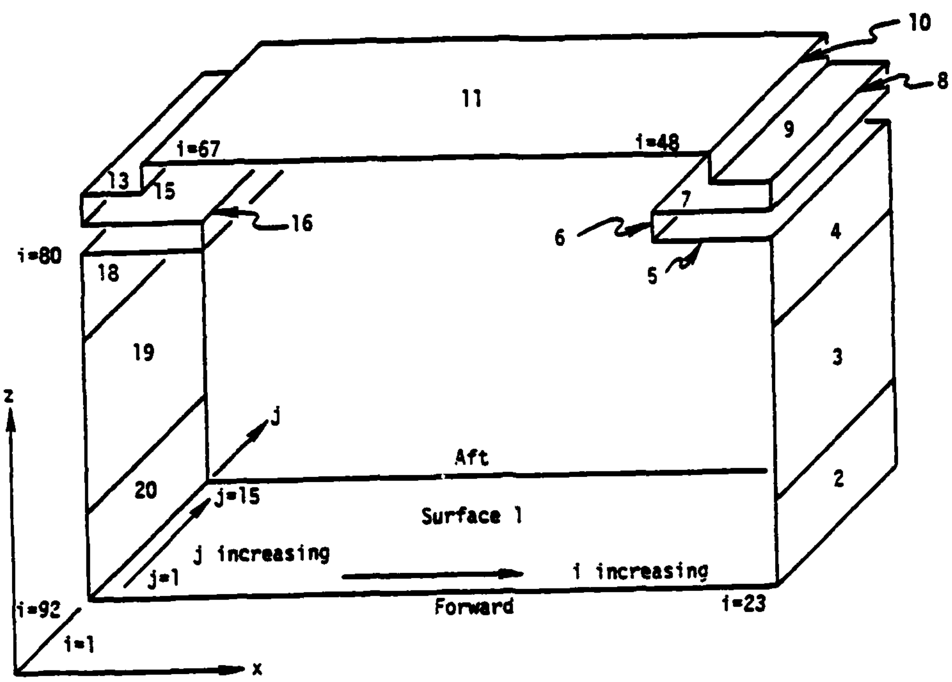

Figure 1. Cabin Lining Surface Numbering and Element Indexing.

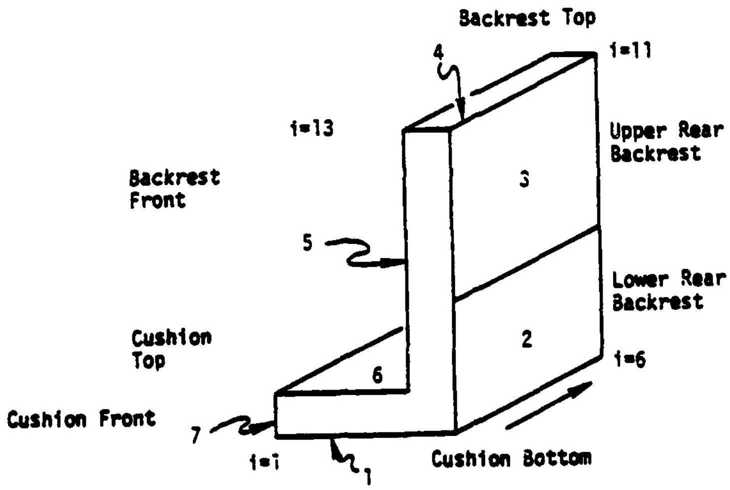

Figure 2. Seat Surface Numbering and Element Indexing.

(3) Each seat group is constructed of seven surfaces as shown in Figure 2. Numbering of the elements starts with the cushion bottom, proceeds up the backrest, over the backrest top, down the front, and over the cushion top and the seat front to return to the edge of the cushion bottom. Since all seat dimensions except the width are fixed, the number of elements on each surface in the direction of the traverse described is fixed. The i-indices of the elements at the edge of each seat surface are shown in Figure 2.

(4) Description of compartment vents must conform to the following assumptions. All vents are rectangular openings in a vertical wall, and may connect adjacent compartments or connect any compartment to the exterior. A single compartment may be unvented or may have any number of vents to a maximum of six.

1.2 PROGRAM STRUCTURE

DACFIR3 consists of two major sections: one to integrate the set of differential equations which model the cabin atmosphere, and one to simulate the spread and course of burning of the cabin interior materials. As the simulation steps ahead in time these two sections are alternately executed to provide the proper coupling and feedback relationships between these two more-or-less separate parts of the problem. As explained in Section 2.4 of Volume I, the time scale for changes in the cabin atmosphere model is much shorter than the scale for changes in the spread simulation. This is due in part to the choice of the size of the elements for discretization of the cabin materials. The difference in scales results in the two-loop structure, shown in Figure 3, for the time stepping procedure. The loop structure contained within the spread simulation tracks the growth of the groups of contiguous burning elements that form the fire bases.

Figure 3 identifies the individual subroutines that constitute the major functional blocks indicated. More information on the purpose of each subroutine is given in Table I. Figure 4 shows the calling arrangement for the major subroutines, the smaller utility subroutines being omitted for clarity of the diagram.

Details of the internal operation of the main program and each subroutine are provided by the many comment lines in the program code. The comments also give the definitions, dimensions, and units of all variables. A listing of the FORTRAN code of DACFIR3 is given in Appendix A.

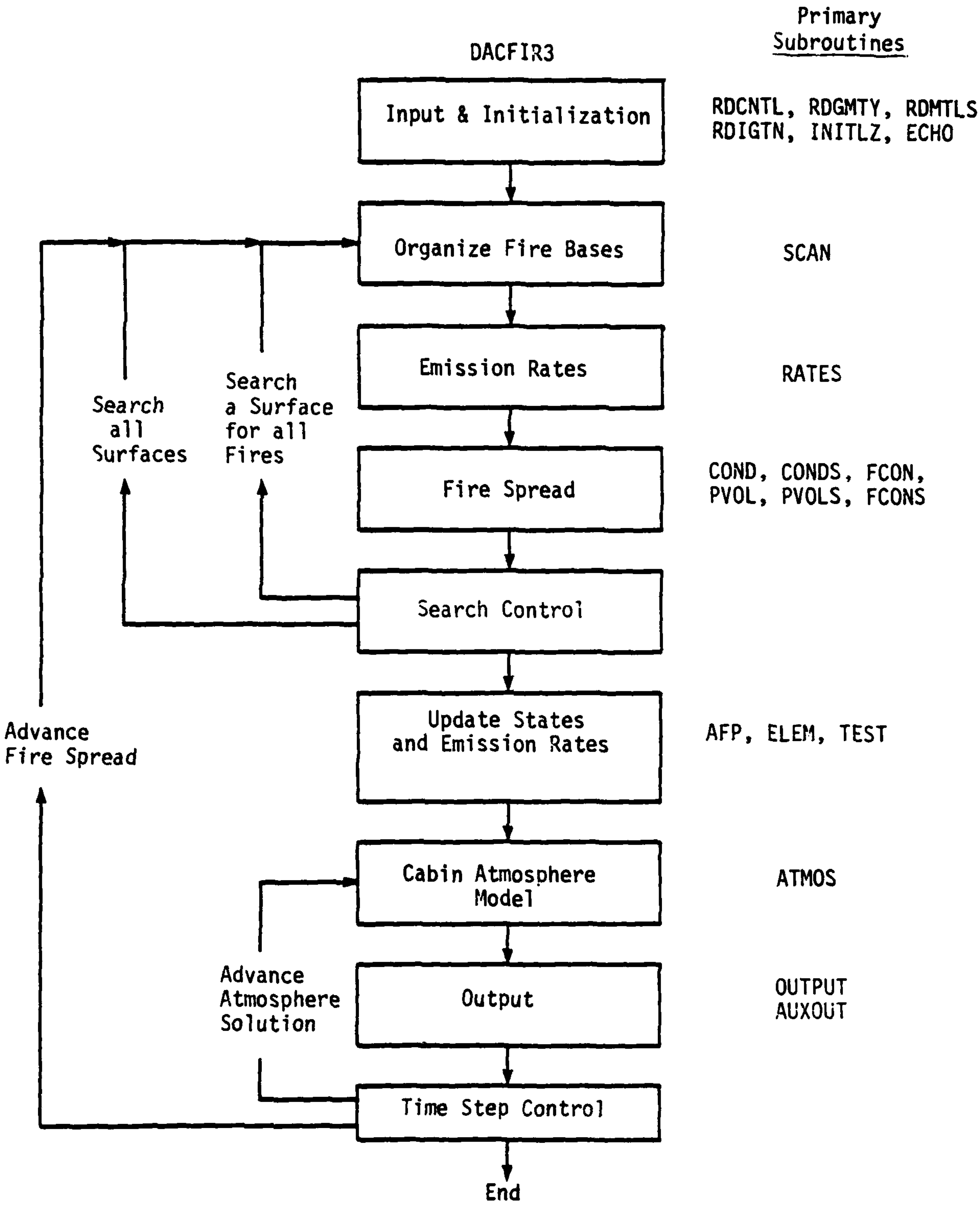

Figure 3. Organization of the DACFIR3 Program.

TABLE I

DACFIR3 SUBROUTINES

Name	Called by	Function
AFP	DACFIR3	Computes the total areas of all materials in the smoldering, flaming, and charred states. Computes the total rates of gas and smoke emission by all materials in the smoldering and flaming states.
ATMOS	DACFIR3	Controlling routine for the integration of the cabin atmosphere equations. One pass through ATMOS produces an update of the atmosphere variables by one small time step.
AUXOUT	DACFIR3	Output routine for writing variables to Unit 8 for plotting or other uses.
COND	DACFIR3	Computes the fire spread to elements adjacent to a fire base for all base areas on lining surfaces.
CONDS	DACFIR3	Computes the fire spread to elements adjacent to a fire base for all base areas on seat surfaces.
CONV	ESET1/ESET2	Finds the convective heat transfer rates between lining surfaces and the gases in each zone.
COVER	CONV	Computes the area of contact between a gas zone and the lining surfaces it touches.
DECOMP	MSLV	Decomposes the Jacobian matrix into the product of a lower-diagonal matrix and an upper diagonal matrix, the first step in solving the linear set employed in the Newton-Raphson solution of the cabin atmosphere equations.
ECHO	DACFIR3	Provides an "echo-check" of the input data and certain initialization procedures.
ELEM	DACFIR3	Scans all elements to make changes of state for elements currently in states 2, 5, 6, and 7. Updates elapsed-time-in-state clock for elements in states 2, 5, and 6 and fraction-consumed clock for state 2 elements.

TABLE I (Continued)

DACFIR3 SUBROUTINES

Name	Called by	Function
ESET1, ESET2	ATMOS, NWTRAP	ESET1 evaluates the terms in the controling equations of the cabin atmosphere model. ESET2 is an alternate entry to this routine which bypasses some sections which need only be evaluated once during a time step.
EXTRAP	ATMOS	Extrapolates from the current values of the cabin atmosphere variables to new values at the next time point to provide a first guess for the iterative solution of the cabin atmosphere equations.
FCON	DACFIR3	Computes the ignition of elements on the lining surfaces by the contact of flames from fires on other, non-adjacent lining surfaces.
FCONS	DACFIR3	Computes the ignition of lining surface elements due to flame contact by fires on the seats.
FIRE	ESET1/ESET2	Finds the total rates of emission of heat, smoke, and gases at the base plane of a fire.
HEIGHT	ESET1/ESET2, INITLZ	Finds the lower zone depth from the lower zone volume and the cabin cross-section.
INIT2	INITLZ	Initializes arrays used to locate the lining surfaces with respect to one another and the seats.
INITLZ	DACFIR3	Initializes most program variables and element states.
MSLV	NWTRAP	Controlling routine for the matrix solution of the linear equation set used in the Newton-Raphson method.
NWTRAP	ATMOS	Controlling routine for the Newton-Raphson iterative method for the solution of the cabin atmosphere equations.

TABLE I (Continued)

DACFIR3 SUBROUTINES

Name	Called by	Function
OUTPUT	DACFIR3	Provides the printed (Unit 6) output for the results of the simulation.
PLUME	ESET1/ESET2	Finds the rates of entrainment of mass, energy, and species into the plume and flame zones of a fire.
PVOL	DACFIR3	Computes the transition of lining surface elements to the smoldering state.
PVOLS	DACFIR3	Computes the transition of seat surface elements to the smoldering state.
RADTN	ESET1/ESET2	Finds the net radiation heat transfer between the gas zones of the cabin atmosphere and the cabin lining surfaces.
RAMP	DACFIR3	Computes the rates of heat, smoke, and gas release during the "ramp-in period," that time when the ignition source fire is building to its maximum burning rate.
RATES	DACFIR3	Computes the flame absorption coefficient; flame-to-fuel radiation levels; and the rates of heat, smoke, and gas release at the base of a fire.
RDCNTL	DACFIR3	Reads in the values of the program control variables.
RDGMTY	DACFIR3	Reads in the values of the variables describing the cabin geometry and initializes arrays pertaining to the element indexing scheme.
RDIGIN	DACFIR3	Reads in the values of the variables describing the ignition mode for the simulation and initializes variables associated with the ignition source fire.
RDMTLS	DACFIR3	Reads in the data describing the cabin interior materials.
RESET	DACFIR3	Resets the indicators of the current and past states of all elements in preparation for the next pass through the fire spread calculations.

TABLE I (Continued)

DACFIR3 SUBROUTINES

Name	Called by	Function
SCALE	ATMOS, ESET1/ESET2, INITLZ	Scales the values of the cabin atmosphere variables "down" to order one, "up" to the appropriate physical order of magnitude, and computes scaling factors for this process.
SCAN	DACFIR3	Searches all lining and seat surfaces in the detailed section to find groups of contiguous state 3 (flaming) elements. Organizes these groups into fire bases and computes a number of parameters associated with each fire.
SOLVE	MSLV	Solves the linear system (matrix equation) employed by the Newton-Raphson solution of the cabin atmosphere equations.
SRFTMP	DACFIR3	Computes the surface temperatures and radiative and convective flux levels to the cabin lining surfaces.
TEST	DACFIR3	For elements in state 3 (flaming) this routine updates the "fraction-consumed" clocks; changes those elements due to burn-out at this time to state 4 (charred); and computes the total rates of heat, smoke, and gas release for all current state 3 elements.
VENT	ESET1/ESET2	Computes the rates of mass flow through a single vent between two compartments or between a compartment and the exterior.
XSEC	CONV, HEIGHT, SRFTMP, INITLZ	Finds the cross-sectional area (perpendicular to the cabin y-axis) of the lower gas zone.

TABLE I (Concluded)

DACFIR3 SUBROUTINES

Name	Called by	Function
		Utility Subroutines
These short subroutines are used in many places throughout the program, mainly for "bookkeeping" functions.		
ISIDE	--	Unpacks data stored in packed form in the array IF.
CVOUT	--	Unpacks data in the arrays ISTATE and ISTATS.
CWORD	--	Unpacks data in the arrays IWORD and IWORDS.
LINT	--	Linearly interpolates in the tables of flammability properties vs. applied heat flux.
ERROR	--	Provides error checking of some input data.

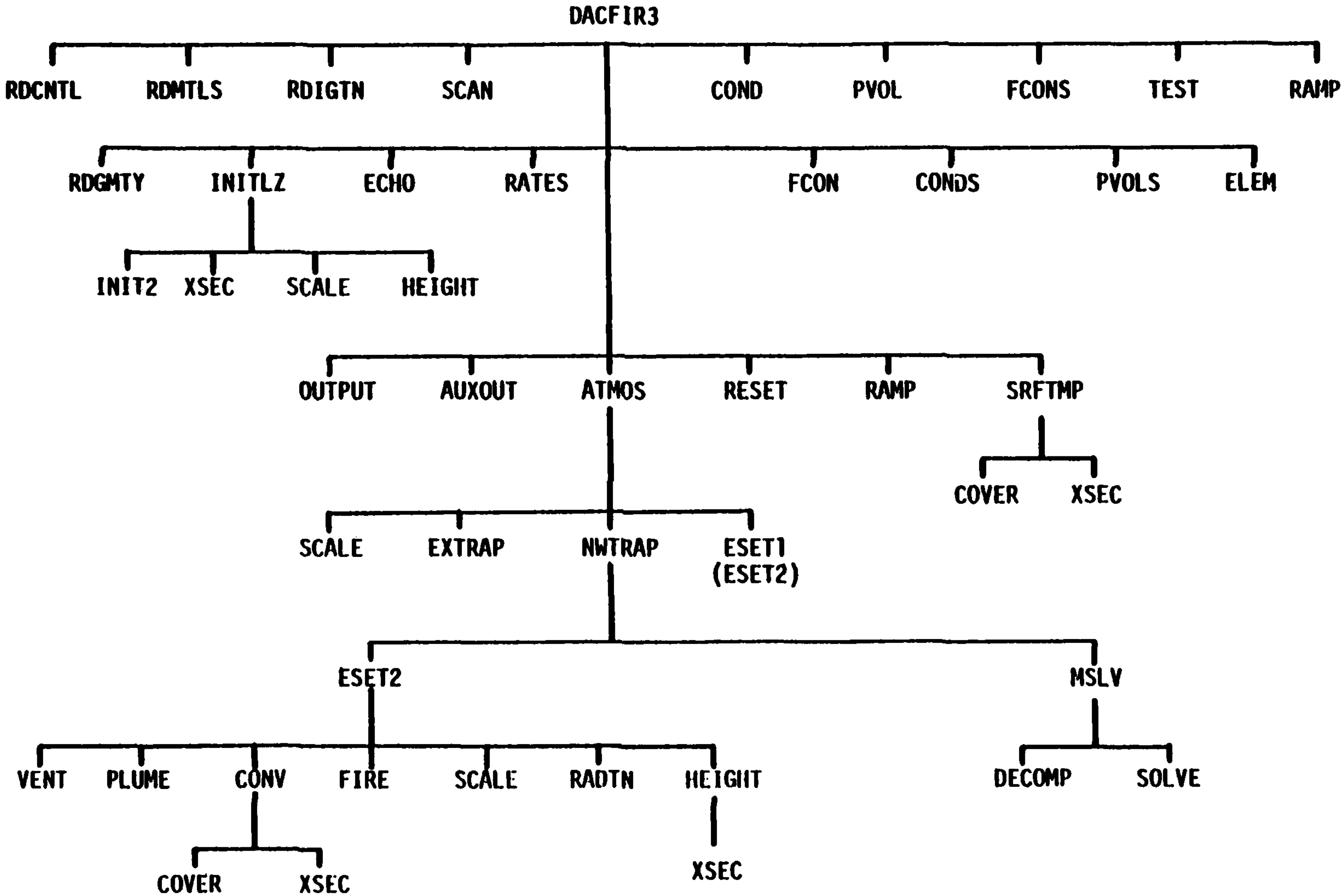

Figure 4. Subroutine Calling Diagram for DACFIR3.

SECTION 2

PREPARATION OF INPUT DATA

This section describes the input requirements for DACFIR3. The preparation of each input record (card) is described including the appropriate variable names, dimensions, and formats. The input data is divided into four types: program control, cabin geometry description, materials flammability data, and the description of the ignition mode. A separate subroutine is used to read each type of data in the order given above. The input data file is read sequentially by these four subroutines. Numbering of the input records is continuous from the start of the file. In Section 3 a sample input file is presented along with a sample of the output created by this data.

DACFIR3 provides, at the user's option, an exhaustive print-out of all the input data at a point in the program before the actual fire simulation begins. The print-out includes the results of the assignments of material types and element indices made by the initialization subroutines. Whenever a new input file is prepared, this "input echo" print-out should be used to verify the data by specifying ECOFLG = 1 in record type 3 of the program control input data.

2.1 PROGRAM CONTROL DATA

Record types 1, 2, and 3 constitute the program control input. One record of each type must appear in the input file.

TABLE II
PROGRAM CONTROL DATA

Record Type	Column	Format	Variable Name	Dimension	Description
1	1-80	20A4	IDENT	20	Run identification.
2	1-10	F10.1	DELTAT	--	Small time step (sec) Minimum value 0.001 sec.
2	11-20	F10.1	TFINAL	--	Stopping time (sec).
2	21-30	F10.1	EPSLN	--	Convergence tolerance for cabin atmosphere calculations (no units).
2	31-35	I5	MAXITR	--	Maximum number of iterations allowed in cabin atmosphere calculations.
2	36-40	I5	MAXCUT	--	Maximum number of time step slices allowed in cabin atmosphere calculations. Maximum value is 3.
2	41-45	I5	JCBSKP	--	Switch to enable skipping of the evaluation of the Jacobian in the gas dynamics calculations. JCBSKP = 1 indicates no skipping. For all other values, the evaluation is skipped if MOD (ITR,JCBSKP) is not equal to zero, where ITR is the iteration number.
2	46-50	I5	IRATIO	--	Ratio of passes through the cabin atmosphere calculations to a pass through the flame spread calculations. Must always be greater than or equal to one.

TABLE II (Concluded)

PROGRAM CONTROL DATA

Record Type	Column	Format	Variable Name	Dimension	Description
2	51-55	I5	ISCALE	--	Modulus to control the frequency of evaluation of scale factors in the cabin atmosphere calculations (milliseconds). If MOD(LT, ISCALE) is equal to zero scale factors are recomputed. LT is the time in milliseconds since the beginning of this small time step. (This value may be less than DELTAT if step cutting is in effect.)
3	1-5	I5	IPEMS	--	Output printing interval (sec) for the cabin atmosphere variables. Must be an integer multiple of DELTAT. Unit 6 output only.
3	6-10	I5	IPSPR	--	Output printing interval (sec) for fire spread calculations. Must be an integer multiple of DELTAT. Unit 6 output only.
3	11-15	I5	IPAUX	--	Flag to control the output of selected variables to Unit 8 for off-line plotting, etc. IPAUX = 1 causes the output to occur, IPAUX = 0 suppresses this output. See the listing of subroutine AUXOUT for the format of this Unit 8 data.
3	16-20	I5	ECOFLG	--	Flag to control the "echo" printing of the input data. ECOFLG = 1 causes printing on Unit 6, ECOFLG = 0 suppresses the printing.

2.2 CABIN GEOMETRY DESCRIPTION

Record types 4 through 13 contain the input data which describes the cabin compartmentation, venting, lining and seating arrangement, materials identification and other items pertaining to the cabin geometry. With the exception of record type 13, at least one record of each type must appear.

TABLE III

CABIN GEOMETRY DESCRIPTION

Record Type	Column	Format	Variable Name	Dimension	Description
4	1-10	F10.1	CH	--	Cabin floor to ceiling height (ft). Must be an integer multiple of 0.5 ft.
4	11-20	F10.1	CW	--	Cabin width at floor (ft). Must be an integer multiple of 0.5 ft.
5	1-5	I5	NCOMPS	--	Number of compartments. Maximum value is 4.
5	6-10	I5	IFRCMP	--	Number of the compartment in which an interior fire can occur.
6	1-40	4F10.1	CL	4	Compartment lengths (ft). Enter the lengths in the order of the compartment numbers.
7	1-5	I5	LSN	--	Number of cabin lining surfaces (excluding partition surfaces.) Maximum value is 20.
7	6-10	I5	NSG	--	Number of seat groups. Maximum value is 9 and minimum value is 1.
7	11-15	I5	ICLL	--	Surface number of the left-most ceiling surface (looking aft).
7	16-20	I5	ICLR	--	Surface number of the right-most ceiling surface (looking aft).

TABLE III (Continued)

CABIN GEOMETRY DESCRIPTION

Record Type	Column	Format	Variable Name	Dimension	Description
One to 20 type 8 records may appear in the file. The exact number is given by the value of LSN. The type 8 records must appear in the order of the surfaces to which they correspond.					
8	1-10	F10.1	SWD	20	Surface "width" (ft). This is the surface dimension in the circumferential direction around the cabin interior and corresponds to the direction of the i element index (See Figure 1). Must be an integer multiple of 0.5 ft.
8	11-20	F10.1	Z	20	Z displacement (height) of the surface from the floor (ft). This value is required only for horizontal surfaces and must be a multiple of 0.5 ft.
8	21-30	F10.1	VN	20,3	x component of the surface normal vector (ft).
8	31-40	F10.1	VN	20,3	y component of the surface normal vector (ft).
8	41-50	F10.1	VN	20,3	z component of the surface normal vector (ft).
8	51-55	I5	IMATL	20	Material identification number for the material of this surface. The material number is determined by the order of input of the materials flammability properties. (See Table IV)
One to nine type 9 records may appear in the file. The exact number is given by the value of NSG.					
9	1-10	F10.1	SGWD	9	Seat group width (ft). Must be a multiple of 0.5 ft.
9	11-20	F10.1	XCOR	9	X-coordinate of the lefthand forward corner of the seat group (ft).

TABLE III (Continued)

CABIN GEOMETRY DESCRIPTION

Record Type	Column	Format	Variable Name	Dimension	Description
9	21-30	F10.1	YCOR	9	Y-coordinate of the lefthand forward corner of the seat group (ft).
Note: The x and y coordinates of the seat group corners are measured with respect to a coordinate system located at the forward lefthand (looking aft) corner of the detailed section. The x-axis of this system extends to the right across the forward edge of the detailed section and the y-axis extends aft.					
10	1-14	7I2	IMATLS	7	Seat surface material identification numbers. The first value is the material number of surface one of all seat groups, the second for surface two, etc. (See Figure 2 for the definition of seat surface numbering).
11	1-10	F10.1	DWS	--	Separation distance between outboard seat groups and sidewalls (ft). Must be a multiple of 0.5 ft.
11	11-20	F10.1	RFWS	--	Flame spread rate from outboard seats to sidewalls (ft/sec).
11	21-40	4I5	IMTLP	4	Material identification number for the partition surfaces of each compartment. Enter in numerical order by the compartment number. Both partition surfaces for a given compartment are of the same material type.
12	1-5	I5	NV	--	Number of vents in the cabin. This is the total number for all compartments. (A vent must not be counted twice if it connects two compartments.) Maximum value is 24; minimum value is zero.

TABLE III (Concluded)

CABIN GEOMETRY DESCRIPTION

Record Type	Column	Format	Variable Name	Dimension	Description
One to 24 records of type 13 may appear; the exact value is given by NV. If NV = 0 do not include any records of type 13. A vent connects one compartment to another or a compartment to the exterior. The numbers of the connected compartments are given by the first two integer numbers in the record. When the vent connects a compartment to the exterior specify the exterior as compartment number 5. No compartment may have more than six vents.					
13	1-5	I5	I1	--	Compartment number (1 to 5).
13	6-10	I5	I2	--	Compartment number (1 to 5 but not equal to I1)
13	11-20	F10.1	VENTT	24	Distance from floor to top of vent opening (ft).
13	21-30	F10.1	VENTH	24	Height of vent opening (ft).
13	31-40	F10.1	VENTW	24	Width (horizontal dimension) of vent opening (ft).
13	41-50	F10.1	FLOW	24	Forced air flow rate through vent (if applicable) ($ft.^3/min$). To specify a "free flow" vent enter this value as 0.
13	51-55	I5	INTO	24	When a non-zero forced flow is specified this variable is the compartment number into which the flow is directed. No value is required if this is a free flow vent.

2.3 MATERIALS FLAMMABILITY DATA

Record types 14 through 36 contain the laboratory flammability data on the cabin materials and additional related information. The number of records of each type will in most cases depend on the number of individual material types used. The numbering of the materials is established by the order in which the type 16 records are read. The material numbering convention set by the reading of the type 16 records must be preserved in ordering the materials data on the following records. This requirement is explained in detail for each record type. Table IV gives specific instructions on the preparation and ordering of the materials data.

TABLE IV

MATERIALS FLAMMABILITY DATA

Record Type	Column	Format	Variable Name	Dimension	Description
14	1-5	I5	NMATLS	--	Number of lining and seat surface material types. Maximum value is seven and the minimum value is one.
14	6-10	I5	NTXG	--	Number of trace gas species to be used in the cabin atmosphere model. Maximum value is five and minimum value is zero.

The number of records of type 15 to be included in the input is given by the value of NTXG, so that a maximum of five and a minimum of zero can appear.

Record Type	Column	Format	Variable Name	Dimension	Description
15	1-4	A4	NGS	--	Alphanumeric name of the trace gas specie. Maximum of four characters is allowed.

The number of records of type 16 to be included in the input is given by the value of NMATLS entered in record type 14. At least one type 16 record must appear. When more than one type 16 record appears, the order of the records establishes the numerical order for the input of all materials data which follows.

Record Type	Column	Format	Variable Name	Dimension	Description
16	1-10	F10.1	QTAB	7	Heat of combustion for this material (Btu/lbm). This is the "effective value" as described in Sec. 4.3 of Volume I.
16	11-20	F10.1	GTAB	7	Stoichiometric oxygen-to-fuel mass ratio for this material (-).

TABLE IV (Continued)

MATERIALS FLAMMABILITY DATA

Record Type	Column	Format	Variable Name	Dimension	Description
16	21-30	F10.1	WMMTL	7	Molecular weight for this material (lbm/lbmole) (sub-unit value or effective value for pyrolyzate vapor)
16	31-40	F10.1	RTAB	7	Pyrolyzate (fuel) vapor density (lbm/ft^3).
16	41-50	F10.1	UTAB	7	Pyrolyzate vapor blowing velocity at the fuel surface (ft/sec).
16	51-60	F10.1	RADTAB	7	Fraction of material's total heat of combustion which is lost by flame radiation (-).

The order of the data items in the record for record types 17 through 20 must be in agreement with the order established for the materials by the type 16 records.

Record Type	Column	Format	Variable Name	Dimension	Description
17	1-80	8F10.1	QP	7	Threshold radiation flux levels for transition to the smoldering state for each material (Btu/ft^2-sec).
18	1-80	8F10.1	TP	7	Transition times to smoldering for each material (sec).
19	1-80	8F10.1	TPC	7	Times for the smoldering-to-charred transition for each material (sec).
20	1-80	8F10.1	RSS	7	Rates of smoke emission for each material in the smoldering state (particles/ft^2-sec).

Type 21 records contain the trace gas species release rates in the smoldering state by each material. Each record contains the rates of release of one species by all materials. The order of the entries in each type 21 record must correspond to the order of the materials as given by the order of the type 16 records. The order of the type 21 records must agree with the order of the type 15 records. If no trace species are to be used, do not include any type 21 records in the input file. Note that each rate is interpreted to be scaled by a factor of 10^6.

TABLE IV (Continued)

MATERIALS FLAMMABILITY DATA

Record Type	Column	Format	Variable Name	Dimension	Description
21	1-80	8F10.1	RGS	5,7	Release rates of each trace gas species (lbm/ft^2-sec) x 10^6.

Record types 22 through 34 contain the flaming state properties for each material. Each record is a table containing six pairs of numbers. The first member of each pair is a radiation flux level (Btu/ft^2-sec) and the second is the appropriate flaming state property for that flux level. The data pairs should be ordered by ascending values of the radiation flux level. The general format is illustrated for record type 22. This format applies for all succeeding record types through 34. The number of records of each type must equal the number of materials and at least one record of each type must appear. The order of the records of one type in a group must agree with the order of materials as established by the order of the type 16 records.

Record Type	Column	Format	Variable Name	Dimension	Description
22	1-5	F5.1	TABX	18,7,6	First radiation flux level (Btu/ft^2-sec).
22	6-13	F8.1	TABY	18,7,6	First horizontal flame spread rate (ft/sec).
22	14-18	F5.1	TABX	18,7,6	Second flux level.
22	19-16	F8.1	TABY	18,7,6	Second flame spread rate.
22	27-31	F5.1	TABX	18,7,6	Third flux level.
22	32-39	F8.1	TABY	18,7,6	Third flame spread rate.
22	40-44	F5.1	TABX	18,7,6	Fourth flux level.
22	45-52	F8.1	TABY	18,7,6	Fourth flame spread rate.
22	53-57	F8.1	TABX	18,7,6	Fifth flux level.
22	58-65	F8.1	TABY	18,7,6	Fifth flame spread rate.
22	66-70	F5.1	TABX	18,7,6	Sixth flux level.
22	71-78	F8.1	TABY	18,7,6	Sixth flame spread rate.

23 6 pairs of flux levels and vertical upward flame spread rates (ft/sec) in the format of type 22.

24 6 pairs of flux levels and vertical downward flame spread rates (ft/sec) in the format of type 22.

TABLE IV (Continued)

MATERIALS FLAMMABILITY DATA

Record Type	Column	Format	Variable Name	Dimension	Description
25	6 pairs of flux levels and times-to-ignite (sec) in the format of type 22.				
26	6 pairs of flux levels and heat release rates (Btu/ft^2-sec) for the flaming state in the format of type 22.				
27	6 pairs of flux levels and smoke release rates (particles/ft^2-sec) for the flaming state in the format of type 22.				
28	6 pairs of flux levels and smoldering lag times (sec) in the format of type 22.				
29	6 pairs of flux levels and times-to-burn out (sec) in the format of type 22.				

Record types 30 through 34 contain the rates of release of the trace gas species in the flaming state. Type 30 records give the rates for the first species, type 31 for the second, etc. If there are fewer than 5 trace gases, omit the corresponding record types. The order of the records within a group of the same record type should follow the material type ordering established by the order of the type 16 records. To save space, all rates of release are scaled by multiplying the values in lbm/ft^2-sec by 10^6.

30	6 pairs of flux levels and release rates of the first trace gas specie (lbm/ft^2-sec) x 10^6 in the format of type 22.				
31	6 pairs of flux levels and release rates of the second trace gas specie (lbm/ft^2-sec) x 10^6 in the format of type 22.				
32	6 pairs of flux levels and release rates of the third trace gas specie (lbm/ft^2-sec) x 10^6 in the format of type 22.				
33	6 pairs of flux levels and release rates of the fourth trace gas specie (lbm/ft^2-sec) x 10^6 in the format of type 22.				
34	6 pairs of flux levels and release rates of the fifth trace gas specie (lbm/ft^2-sec) x 10^6 in the format of type 22.				

Record type 35 contains the bulk thermal properties of the materials, one record for each material type. The number and order of the type 35 records must follow that established by the type 16 records.

TABLE IV (Concluded)

MATERIALS FLAMMABILITY DATA

Record Type	Column	Format	Variable Name	Dimension	Description
35	1-10	F10.1	CPM	7	Specific heat capacity of the material (Btu/lbm-R).
35	11-20	F10.1	RHOM	7	Density of the material (lbm/ft^3).
35	21-30	F10.1	TKNS	7	Material thickness (ft).
35	31-40	F10.1	CNDCTY	7	Thermal conductivity* for the insulation behind this material (Btu/ft-sec-R).
35	41-50	F10.1	TKNSIN	7	Insulation thickness* (ft).
*Insulation properties are required only for cabin lining surface materials.					
36	1-10	F10.1	TAM	--	Ambient temperature (R).
36	11-20	F10.1	PAMB	--	Ambient pressure (lbf/ft^2)

2.4 IGNITION MODE

Record types 37 through 47 describe the mode of ignition of the cabin fire including the characteristics of the ignition fire fuel and gases which may enter the cabin from an exterior fire.

TABLE V

IGNITION MODE DATA

Record Type	Column	Format	Variable Name	Dimension	Description
37	1-10	F10.1	QCI	--	Heat of combustion of the ignition fire fuel (Btu/lbm) (Use the total value, not the "effective" value as in the case of the cabin materials).
37	11-20	F10.1	GAMI	--	Stoichiometric oxygen-to-fuel mass ratio for the ignition fire fuel (-).
37	21-30	F10.1	WMIGN	--	Molecular weight of the ignition fire fuel (lbm/lbmole) (sub-unit value or effective value for pyrolyzate vapor).
37	31-40	F10.1	RHOI	--	Pyrolyzate (fuel) vapor density (lbm/ft^3) of the ignition fire fuel.
37	41-50	F10.1	XMUI	--	Pyrolyzate (fuel) vapor blowing velocity (ft/sec) of the ignition fire fuel.
37	51-60	F10.1	RADI	--	Fraction of the heat of combustion of the ignition fire fuel that is lost by flame radiation (-).
37	61-70	F10.1	XMFI	--	Amount of ignition fire fuel (lbm). This quantity and the values of RHOI, XMUI, and RAMPT will determine the duration of the ignition fire. See below.
38	1-10	F10.1	DQI	--	Heat release rate for the ignition fire (Btu/ft^2-sec).

TABLE V (Continued)

IGNITION MODE DATA

Record Type	Column	Format	Variable Name	Dimension	Description
38	11-20	F10.1	RAMPT	--	"Ramp-in" time for the ignition fire (sec). May be entered as 0.0 if no ramp-in period is desired.
39	1-10	F10.1	RSI	--	Smoke release rate of the ignition fire (particles/ft^2-sec).

Columns 11 through 60 of record type 39 contain the rates of release of the trace gases by the ignition fire. Entries need only be made for the particular number of gases to be used for a given case. The order of the rates must conform to the species order established by the type 15 records.

Record Type	Column	Format	Variable Name	Dimension	Description
39	11-20	F10.1	RTGI	5	Release rate of the first trace gas by the ignition fire (lbm/ft^2-sec) x 10^6.
39	21-30	F10.1	RTGI	5	Release rate of the second trace gas by the ignition fire (lbm/ft^2-sec) x 10^6.
39	31-40	F10.1	RTGI	5	Release rate of the third trace gas by the ignition fire (lbm/ft^2-sec) x 10^6.
39	41-50	F10.1	RTGI	5	Release rate of the fourth trace gas by the ignition fire (lbm/ft^2-sec) x 10^6.
39	51-60	F10.1	RTGI	5	Release rate of the fifth trace gas by the ignition fire (lbm/ft^2-sec) x 10^6.
40	1-5	I5	IGSN	--	Lining surface number on which the ignition fire is located.

TABLE V (Continued)

IGNITION MODE DATA

Record Type	Column	Format	Variable Name	Dimension	Description
41	1-5	I5	NIJSQ	--	Number of surface elements which make up the base area of the ignition fire. Maximum value of 100 and a minimum value of 1.
41	6-15	F10.1	PIGN	--	Length of the perimeter of the base area of the ignition fire (ft).

Record type 42 contains the I and J indices of the elements which form the base of the ignition fire, one pair of indices per record. The total number of records must be equal to the value of NIJSQ on record type 41. Order of the type 42 records is not important.

Record Type	Column	Format	Variable Name	Dimension	Description
42	1-5	I5	IGNIJ	2,100	I index of an ignition fire base element.
42	6-10	I5	IGNIJ	2,100	J index of an ignition fire base element.

Record types 43 and 44 may be used to set any number of lining surface elements to the charred, and thus inert, state. If no elements are to be so set, enter a value of zero on record type 43 and do not include any records of type 44.

Record Type	Column	Format	Variable Name	Dimension	Description
43	1-5	I5	NIJC	--	Number of lining surface elements to be set to the charred state. Maximum value is 600.
44	1-5	I5	I	--	I index of a charred element.
44	6-10	I5	J	--	J index of a charred element.

Record types 45, 46, and 47 allow the user to specify the inflow of exterior fire gases through a compartment vent. If no such inflow is to be specified, enter a value of zero on record type 45 and omit record types 46 and 47.

TABLE V (Continued)

IGNITION MODE DATA

Record Type	Column	Format	Variable Name	Dimension	Description
45	1-5	I5	IFRVNT	--	Vent number through which exterior fire gases may enter.
46	1-10	F10.1	RHOEFG	--	Density of the exterior fire gases (lbm/ft^3).
46	11-20	F10.1	TEFG	--	Temperature of the exterior fire gases (R).
46	21-30	F10.1	FLOWIN	--	Mass inflow rate of exterior fire gases (lbm/sec).
46	31-40	F10.1	FLWOUT	--	Mass outflow rate of compartment lower zone gases (lbm/sec).
47	1-10	F10.1	CHIEFG	11	Mass fraction of N_2 in the exterior fire gases (-).
47	11-20	F10.1	CHIEFG	11	Mass fraction of O_2 in the exterior fire gases (-).
47	21-30	F10.1	CHIEFG	11	Mass fraction of fuel vapor in the exterior fire gases (-).
47	31-40	F10.1	CHIEFG	11	Mass fraction of the CO_2 in the exterior fire gases (-).
47	41-50	F10.1	CHIEFG	11	Mass fraction of the H_2O in the exterior fire gases (-).
47	51-60	F10.1	CHIEFG	11	Mass fraction of the first trace specie in the exterior fire gases (-).
47	71-80	F10.1	CHIEFG	11	Mass fraction of the third trace specie in the exterior fire gases (-).

TABLE V (Concluded)

IGNITION MODE DATA

Record Type	Column	Format	Variable Name	Dimension	Description
If more than two trace species are to be used, include a second type 47 record for the remaining species and smoke content of the exterior fire gases. If one or two species are used, all the exterior fire gas composition data may be included in the one type 47 record.					
47	1-10	F10.1	CHIEFG	11	Mass fraction of the fourth trace specie in the exterior fire gases (-).
47	11-21	F10.1	CHIEFG	11	Mass fraction of the fifth trace specie in the exterior fire gases (-).
47	21-30	F10.1	CHIEFG	11	Concentration of smoke in the exterior fire gases (particles/lbm).

The user has the option of "ramping-in" the ignition fire, that is, allowing the fire heat and product release rate to grow linearly over a specified time period until the maximum burning rate is reached. This capability was added to DACFIR3 to allow a more realistic simulation of a common method of ignition in full-scale tests, pool fires of liquid fuels.

To prepare consistent values for the data items on record types 37 and 38, the following relationships among these properties of the ignition fire and fuel should be noted. (1) The product of the mass burning rate, given by (RHOI)·(XMUI), and the effective heat of combustion should equal the specific heat release rate:

DQI = (RHOI)·(XMUI)·(I-RADI)·(QCI).

The values of DQI, RSI, and RTGI are the maximum release rates of heat, smoke, and gases for the fully developed ignition fire which will be obtained after the ramp-in period. (2) During the ramp-in period, the values of the heat, smoke, and gas release rates and oxygen consumption rate start at a value of 1/(1 + RAMPT/DELTAT) of their maximum values and increase linearly to their maximum values at the end of the period given by RAMPT. (3) The total duration of burning of the ignition fire is computed by the program from the input values of XMFI, RHOI, XMUI, RAMPT, and NIJSQ as follows:

AFI = (0.25)·(NIJSQ)

TBURNI = (0.5)·(RAMPT) + (XMFI) / ((AFI)·(RHOI)·(XMUI))

where TBURNI is the duration of burning in seconds.

SECTION 3

SAMPLE INPUT AND OUTPUT

Table VI gives a sample input data file for DACFIR3. This is the data file used to simulate Test 14A discussed in Section 6 of Volume I. This case involved a single compartment, two vents to the exterior, and no exterior fires. The ignition fire was a one square foot pan of Jet A fuel. Four interior material types were used and five trace gas species concentrations were computed. The other data items, such as integration step size and convergence tolerance, are typical of the values used in all the testing of DACFIR3 to date.

Table VII shows the output of DACFIR3 at the simulated time of 120 seconds after ignition for Test 14A.

TABLE VI

DACFIR3 SAMPLE INPUT DATA

```
 DACFIR3 TEST 14A  24-MAY-1981 02:00:00
2.0       420.       0.0001       10    6    1    4    5
    4    4  999     0
7 0       11.0
    1    1
56 0
    8    1    7    3
        11.         0.         0.         0.         1.    1
         6.         0.        -1.         0.         0.    2
         3.         6.         0.         0.        -1.    3
         1.         6.        -1.         0.         0.    2
         5.         7.         0.         0.        -1.    2
         1.         6.         1.         0.         0.    2
         3.         6.         0.         0.        -1.    3
         6.         0.         1.         0.         0.    2
4.5       6.0        3.0
 4 4 4 4 4 4 4
0.5       0.1             2
    2
    1    5         5.         5.        2.5       500.    1
    1    5         5.         5.        2.5         0.    0
    4    5
CO        28.
HCL       36.5
HCN        27.
HF        20.
NO2        46.
7000.     3.00       100.       0.075      0.10      0.3
7000.     3.00       100.       0.075      0.10      0.3
7000.     3.00       100.       0.075      0.10      0.3
9971.     2.19       130.       0.0735     0.0975    0.4
2.2       2.2        2.2        2.2
9999.     25.0       310.       13.0
9999.     65.0       443.       162.0
0.        14.5       57.1       8.31
0.        71.5       0.72       43.7
0.        5.0        1.1        1.43
0.        0.414      0.0        0.324
0.        36.0       0.0        0.0
0.0       0.0        0.0        0.0
0.   0.      1.   0.      2.   0.      3.   0.      4.   0.      5.   0.
0.   0.      1.32 0.      2.2  0.0172  3.08 0.0417  4.4  0.081   6.   0.128
0.   0.      1.32 0.0018  2.2  0.0048  3.08 0.0085  3.96 0.0112  6.   0.0175
0.   0.00612 1.32 0.00612 2.2  0.0171  3.08 0.0261  4.4  0.0695  6.   0.1220
0.   0.      1.   0.      2.   0.      3.   0.      4.   0.      5.   0.
0.   0.      1.32 0.0455  2.2  0.05    3.08 0.0982  4.4  0.125   6.   0.157
0.   0.      1.32 0.0018  2.2  0.0048  3.08 0.0085  3.96 0.0112  6.   0.0175
0.   0.00610 1.32 0.00610 2.2  0.0217  3.08 0.0591  4.4  0.0982  6.   0.1560
0.   0.      1.   0.      2.   0.      3.   0.      4.   0.      5.   0.
0.   0.      1.32 0.00543 2.2  0.0172  3.08 0.0684  4.4  0.0833  6.   0.1010
0.   0.      1.32 0.0018  2.2  0.0048  3.08 0.0085  3.96 0.0112  6.   0.0175
0.   0.00610 1.32 0.00610 2.2  0.0178  3.08 0.0384  4.4  0.0571  6.   0.0797
0.   999.    1.   999.    2.   999.    3.   999.    4.   999.    5.   999.
0.   6.      1.32 5.67    2.2  5.3     3.08 5.55    4.4  4.56    6.   4.56
0.   10.     1.32 9.5     2.2  4.      3.08 6.7     3.96 3.3     6.   3.3
0.   12.     1.32 12.     2.2  4.      3.08 4.3     4.4  3.22    6.   3.22
0.   0.      1.   0.      2.   0.      3.   0.      4.   0.      5    0.
0.   1.      1.32 1.47    2.2  2.23    3.08 2.64    4.4  1.73    6.   1.73
0.   1.      1.32 1.47    2.2  3.18    3.08 6.56    3.96 5.22    6.   5.22
0.   1.17    1.32 1.17    2.2  2.29    3.08 2.47    4.4  4.25    6    4.25
0.   0.      1    0.      2.   0.      3    0       4    0       5    0.
```

TABLE VI (Concluded)

DACFIR3 SAMPLE INPUT DATA

```
0.      10.        1.32 14.6     2.2  25.1      3.08 9.12      4.4  17.4     6.     27.4
0.      20.        1.32 25.1     2.2  39.2      3.08 89.7      3.96 7.9      6.     7.9
0.      3.29       1.32 3.29     2.2  9.09      3.08 11.6      4.4  17       6.     23.5
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        4.4  0.       6.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        3.96 0.       6      0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        4.4  0.       6.     0.
0.      999.       1.   999.     2.   999.      3.   999.      4.   999.     5.     999.
0.      15.        1.32 67.      2.2  83.3      3.08 189.      4.4  241.     6.     304.
0.      550.       1.32 477.5    2.2  534.      3.08 298.7     3.96 339.3    6.     433.3
0.      760.       1.32 760.     2.2  646.      3.08 666.      4.4  643.     6.     615.
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 8.29     2.2  183.      3.08 150.      4.4  107.     6.     107.
0.      25.        1.32 30.      2.2  35.5      3.08 92.2      3.96 143.6    6.     263.
0.      100.       1.32 100.     2.2  143.      3.08 147.      4.4  236.     6.     344.
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 0.       2.2  0.        3.08 1.53      4.4  15.      6.     31.3
0.      4.         1.32 5.       2.2  5.1       3.08 12.7      3.96 18.7     6.     6.94
0.      0.         1.32 0.       2.2  0.        3.08 1.99      4.4  4.23     6.     4.23
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.283     4.4  0.222    6.     0.222
0.      0.         1.32 0.       2.2  0.        3.08 0.        3.96 0.       6.     0.
0.      0.         1.32 1.       2.2  4.66      3.08 4.9       4.4  11.      6.     18.
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 29.6     2.2  45.2      3.08 15.7      4.4  12.3     6.     12.3
0.      0.         1.32 0.       2.2  0.        3.08 0.        3.96 0.       6.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        4.4  0.       6.     0.
0.      0.         1.   0.       2.   0.        3.   0.        4.   0.       5.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        4.4  0.       6.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        3.96 0.       6.     0.
0.      0.         1.32 0.       2.2  0.        3.08 0.        4.4  1.07     6.     1.07
0.25         75.          0.004        0.000084  0.25
0.25         75.          0.004        0.000084  0.25
0.25         75.          0.021        0.000084  0.25
0.25         75.          0.500        0.000084  0.25
542.0        2116.29
18500.       3.43         130.         0.544     0.00476    0.10       0.74
43.2         20.
43.0         34.1         0.0          0.0       0.0        0.0
    1
    4    4.
   20    7
   20    8
   21    7
   21    8
    0
    0
```

TABLE VII. DACFIR3 SAMPLE OUTPUT

TIME= 120.000 SECONDS   DACFIR3 TEST 14A 24-MAY-1981 02.00.00

COMPARTMENT	ZONE	DEPTH (FT)	VOLUME (CU FT)	GAS TEMP (F)	GAS DENSITY (LBM/CU FT)	SMOKE CONC (OD/FT)	MASS FRACTIONS OF MAJOR GASES O2	CO2	H2O	PRESSURE (LBF/SQ FT)
1	UPPER	2.615	1275.7	120.26	0.06651	0.221	0.21920	0.00072	0.00029	2120.33
	LOWER	4.385	2700.3	83.56	0.07305	0.000	0.23000	0.00000	0.00000	

ZONE	GAS CONCENTRATIONS (PPM) N2	O2	FUEL	CO2	H2O	CO	HCL	HCN	HF	NO2
UPPER	795463	202923	0.	483	483	583.	25	6.	33	0
LOWER	792793.	207207.	0.	0.	0.	0.	0.	0.	0	0

INTERIOR FIRES

FIRE	BASE AREA (SQ FT)	VAPOR GEN RATE (CU FT/SEC)	HEAT GEN RATE (BTU/SEC)	PLUME ENTRMNT (CU FT/SEC)	FLAME LENGTH (FT)	ABSN COEFF (1/FT)	SMOKE GEN FATE (PART/SEC)	OXY CNSPTN RATE (LBM/SEC)
1	1.00	0.100000E+00	0.432000E+02	0.923441E+01	2.98	0.922202E+00	0.430000E+02	0.800951E-02
2	1.00	0.100000E+00	0.000000E+00	0.171181E+02	2.49	0.250000E+00	0.000000E+00	0.000000E+00
3	6.00	0.600000E+00	0.166325E+02	0.284569E+02	5.75	0.489022E+00	0.291751E+03	0.690622E-02
4	2.50	0.250000E+00	0.605500E+01	0.387183E+02	3.96	0.470519E+00	0.885622E+02	0.259500E-02
5	4.50	0.450000E+00	0.250849E+02	0.439888E+02	4.93	0.124964E+01	0.337386E+03	0.107507E-01
6	3.25	0.316875E+00	0.138125E+02	0.537463E+02	4.24	0.319199E+00	0.577233E+02	0.303374E-02
7	2.00	0.195000E+00	0.234000E+01	0.612826E+02	3.20	0.680666E-01	0.658000E+01	0.513951E-03

TRACE GAS GENERATION RATES (LBM/SEC)

FIRE	CO	HCL	HCN	HF	NO2
1	0.341000E-04	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3	0.106057E-02	0.345642E-03	0.724816E-05	0.110700E-03	0.267500E-06
4	0.374500E-03	0.975894E-04	0.777000E-06	0.430500E-04	0.000000E+00
5	0.340501E-03	0.471776E-04	0.000000E+00	0.000000E+00	0.000000E+00
6	0.808095E-03	0.137475E-04	0.384135E-04	0.000000E+00	0.347750E-05
7	0.200000E-03	0.000000E+00	0.136867E-05	0.000000E+00	0.000000E+00

SURFACE CONDITIONS

SURFACE	CONTACT AREA (SQ FT) UPPER ZONE	LOWER ZONE	CONVECTIVE FLOW (BTU/SEC) UPPER ZONE	LOWER ZONE	RADIATIVE FLOW (BTU/SEC) UPPER ZONE	LOWER ZONE	TEMPERATURE (F) UPPER PART	LOWER PART
1	0.000	616.000	0.000	-5.509	0.000	41.796	99.991	99.991
2	90.458	245.542	0.976	-2.196	4.810	16.660	100.933	99.991
3	168.000	0.000	2.958	0.000	8.934	0.000	88.336	88.336
4	56.000	0.000	0.622	0.000	2.978	0.000	100.380	100.380
5	280.000	0.000	3.110	0.000	14.890	0.000	100.380	100.380
6	56.000	0.000	0.622	0.000	2.978	0.000	100.330	100.380
7	168.000	0.000	2.958	0.000	8.934	0.000	88.396	88.386
8	90.458	245.542	0.976	-2.196	4.810	16.660	100.933	99.971
PARTN								
1	22.768	48.232	0.253	-0.442	1.211	3.273	100.380	100.335
2	22.768	48.232	0.253	-0.442	1.211	3.273	100.389	100.385
TOTAL	954.452	1203.548	12.727	-10.786	50.755	81.641		

VOLUME AND ENERGY FLOW RATES THRU VENTS (CU FT/SEC), (BTU/SEC)

VENT	1	2
CONNECTS	1 TO 5	1 TO 5
NET UPR-UPR		
VOLUME	0.000000E+00	0.685203E+02
ENERGY	0.000000E+00	0.634257E+03

TABLE VII (Continued). DACFIR3 SAMPLE OUTPUT

```
NET LWR-LWR
 VOLUME     0 500000E+03    0 443618E+03
 ENERGY     0 475364E+04    0 422564E+04

SOLUTION DATA - TIME STEPS IN MILLISECONDS
 STEP  2000  ITR  2   STEP  2000  ITR  9   STEP
```

ELEMENT STATE SUMMARY - CONDITIONS ON ALL SURFACES AT END OF FLAME SPREAD CALCULATIONS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
SMOLDERING	0	0	0	0	0	0	0	0	0																		
FLAMING	10	50	18	0	0	0	0	0	22																		
CHARRED	0	0	0	0	0	0	0	0	0																		

FLAMING, SMOLDERING, AND CHARRED AREAS BY MATERIAL TYPE (SQ FT)

MATERIAL NO	1	2	3	4
AREA AFLAME	2 50	12 50	4 50	5 50
AREA SMLDRG	0.00	0.00	0.00	0.00
AREA CHRRD	0.00	0.00	0.00	0.00

TIME= 120 000 SECONDS DACFIR3 TEST 14A 24-MAY-1981 02 00 00

DISTRIBUTION OF ELEMENTAL STATES AT END OF FLAME SPREAD CALCULATIONS

INTEGERS CORRESPOND TO STATES OF INDIVIDUAL ELEM-

1=AMBIENT STATE
2=SMOLDERING STATE
3=AFLAME
4=CHARRED
5=HEATING, NOT IN CONTACT WITH FLAME
6=HEATING, IN CONTACT WITH FLAME
7=SMOLDERING, COOLING

```
        AFT
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111113331111111111111111111111111111111111111111111111
        111111111111111111111113333311111333111111111111111111111111111111111111
        111111111111111111111113333331111333331111111111111111111111111111111111
        111111111111111111111333333333113333333311111111111111111111111111111111
        111111111111111111111333333333113333333311111111111111111111111111111111
        111111111111111111111113333331111333331111111111111111111111111111111111
        111111111111111111111113333311111333111111111111111111111111111111111111
        111111111111111111111113331111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
        111111111111111111111111111111111111111111111111111111111111111111111111
LINING
  SURF  000000000000000000000000000000000000000000000000000000000000000000000000
NUMBER  111111111111111111111111222222222223333333445555555555667777778888888888
```

TIME= 120 000 SECONDS DACFIR3 TEST 14A 24-MAY-1981 02 00 00

TABLE VII (Concluded). DACFIR3 SAMPLE OUTPUT

```
FOR SEAT GROUPS---J= 1- 4   CUSHION.BOTTOM
                  J= 5- 7   BACKREST.LWR REAR
                  J= 8-11   BACKREST.UPR REAR
                  J=12      BACKREST.TOP
                  J=13-18   BACKREST.FRONT
                  J=19-21   CUSHION.TOP
                  J=22      CUSHION.FRONT


SEAT GROUP NO 1


-____________________
                     22  111111333
-____________________
 CUSHION.FRONT
                     21  111111133
                     20  111111133
 CUSHION.TOP
                     19  111111113
_____________________
                     18  111111111
                     17  111111111
                     16  111111111
 BACKREST.FRONT
                     15  111111111
                     14  111111111
                     13  111111111
-____________________
                     12  111111111
-____________________
 BACKREST.TOP
                     11  111111111
                     10  111111111
 BACKREST.UPR REAR
                      9  111111111
                      8  111111111
-____________________
                      7  111111111
                      6  111111111
 BACKREST.LWR REAR
                      5  111111113
-____________________
                      4  111111133
                      3  111111333
 CUSHION.BOTTOM
                      2  111113333
                      1  111113333
-____________________
```

SECTION 4

PROGRAM STATISTICS

The DACFIR3 computer program is written in FORTRAN IV and conforms to the 1966 ANSI standard for this language. The code consists of approximately 4050 source statements augmented by about 2250 comment lines. The comments define all important variables and detail the function of all parts of the code. A complete listing of DACFIR3 is contained in Appendix A of this volume.

The computer requirements for running DACFIR3 will differ among different computer systems, but the following data should serve as a rough guide to the computer requirements involved. The data are for a run made using the sample input data given in Section 3. The computer was a Digital Equipment Corporation VAX-11/780 with 1.5 mbytes of physical memory and a speed of about 700,000 instructions per second. Peak virtual memory required was 326,000 bytes. The execution time (cpu time) required was 1500 seconds to simulate 400 seconds of the fire test. A considerable variation of these figures can be expected if other values for the number of materials, number of compartments, number of trace gases, integration step size, or convergence tolerance are chosen.

SECTION 5

REFERENCES

1. Reeves, J. B., and C. D. MacArthur, "Dayton Aircraft Cabin Fire Model," Volumes I, II, and III, FAA-RD-76-120, June 1976. Volume III, "Computer Program User's Guide" was written by P. M. Kahut.

2. MacArthur, C. D., and J. F. Myers, "Dayton Aircraft Cabin Fire Model Validation - Phase 1," FAA-RD-78-57, March 1978.

APPENDIX A

LISTING OF THE DACFIR3 COMPUTER CODE

This appendix contains the listing of the DACFIR3 computer code. The language is FORTRAN IV and conforms to ANSI standard FORTRAN (X3.9-1966).

Copies of the program may be obtained by contacting the author at the University of Dayton, telephone (513) 229-3921.

```
      PROGRAM DACFIR
C
C -------------------------------------------------------------------
C
C      COMPUTER SIMULATION OF FIRE WITHIN A TRANSPORT AIRCRAFT CABIN
C
C                         VERSION 3.0 --- 1 APR 1981
C
C
C  MODEL AND CODE CREATED FOR DOT/FEDERAL AVIATION ADMINISTRATION
C  BY THE UNIVERSITY OF DAYTON RESEARCH INSTITUTE  DAYTON, OHIO 45469
C
C   REFERENCES:
C
C      [1] "DAYTON AIRCRAFT CABIN FIRE MODEL VERSION 3",
C           VOLUME 1 -- PHYSICAL DESCRIPTION
C
C      [2] "DAYTON AIRCRAFT CABIN FIRE MODEL VERSION 3",
C           VOLUME 2 -- PROGRAM USER'S GUIDE AND LISTING
C
C -------------------------------------------------------------------
C
C ABBREVIATIONS USED IN THE PROGRAM COMMENTS:
C
C          AMB     = AMBIENT
C          APNDX   = APPENDIX
C          AVG     = AVERAGE
C          CALCS   = CALCULATIONS
C          CONCS   = CONCENTRATIONS
C          CRCTN   = CORRECTION
C          DEFN    = DEFINITION
C          ELMNT   = ELEMENT
C          EXCHNG  = EXCHANGE
C          FP      = FORMAL PARAMETER
C          GRP     = GROUP
C          ID      = IDENTIFICATION
C          IGN SRC= IGNITION SOURCE
C          INFO    = INFORMATION
C          LWR     = LOWER
C          MATL    = MATERIAL
C          MAX     = MAXIMUM
C          MIN     = MINIMUM
C          NEG     = NEGATIVE
C          NO      = NUMBER
C          PARTS   = PARTICLES (A MEASURE OF SMOKE DENSITY, SEE [1])
C          PGM     = PROGRAM
C          POS     = POSITIVE
C          PRDCTN  = PRODUCTION
C          PSTN    = POSITION
C          RT      = RIGHT
C          SUBSCR  = SUBSCRIPT
C          SMLDRG  = SMOLDERING
C          SPRD    = SPREAD
C          STMT    = STATEMENT
C          SUBR    = SUBROUTINE
C          SURF    = SURFACE
C          VOL     = VOLUME
C          VRBL    = VARIABLE
C          WRT     = WITH RESPECT TO
C          ZN      = ZONE
C
```

```
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'CNTRL':
C
C DELTAT = SMALL TIME STEP SIZE (SEC).  USED IN GAS DYNAMICS CALCULATIONS
C DELTSP = LARGE TIME STEP SIZE (SEC).  USED IN FLAME SPREAD CALCULATIONS
C ECOFLG = FLAG TO CONTROL INPUT ECHO PRINTING
C IDELT  = SMALL TIME STEP OF THE SIMULATION, VALUE IN MILLISECONDS.
C IDENT  = ARRAY FOR STORING RUN ID (ALPHANUMERIC) DATA
C IDTPRV = PREVIOUS SMALL TIME STEP (MILLISECONDS)
C IPEMS  = FLAG TO CONTROL PRINTING OF CABIN ATMOSPHERE DATA BY SUBR
C          OUTPUT.  VALUE = 1 => PRINT DATA ON THIS PASS
C IPSPR  = FLAG TO CONTROL PRINTING OF FLAME SPREAD DATA BY SUBR OUTPUT
C          VALUE = 1 => PRINT DATA ON THIS PASS
C IRATIO = RATIO OF PASS THRU THE CABIN ATMOSPHERE CALCULATIONS TO A
C          PASS THRU THE FLAME SPREAD CALCULATIONS  VALUE >= 1 ALWAYS
C ISAVE  = A FLAG TO CONTROL NO OF SCANS OF A SURF BY SUBR FIRE.
C ISCALE = MODULUS FOR RECOMPUTING SCALE FACTORS
C ITFIN  = STOPPING TIME FOR THE RUN IN MILLISECONDS.
C ITIME  = MAIN TIME CLOCK FOR THE SIMULATION.  VALUE IN MILLISECONDS.
C ITIM2  = CLOCK FOR TIMING PASSES THRU FLAME SPREAD CALCULATIONS
C          ITIM2 IS INCREMENTED BY ITSPRD EACH FLAME SPRD PASS.  VALUE IN
C          MILLISECONDS
C ITSPRD = TIME INTERVAL BETWEEN PASSES THRU THE FLAME SPREAD
C          CALCULATIONS.  VALUE IN MILLISECONDS.
C TFINAL = STOPPING TIME FOR SIMULATION RUN, SECONDS.
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1              IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2              ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3              JCBSKP
C IDBUG1 = SWITCH FOR DEBUGGING CONTROL (INACTIVE)
C EPSLN  = CONVERGENCE TOLERANCE GAS DYNAMICS CALCS.
C MAXITR = MAXIMUM NUMBER OF ITERATIONS ALLOWED IN GAS DYNAMIC CALCS.
C MAXCUT = MAXIMUM NUMBER OF TIME STEP SLICES ALLOWED IN GAS DYNAMICS
C          CALCS.
C JCBSKP = SWITCH FOR SELECTIVE SKIPPING OF JACOBIAN EVALUATION IN GAS
C          DYNAMICS CALCS.
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'FIRES':
C
C AFM    = AREA OF EACH MATERIAL TYPE CURRENTLY FLAMING (FT*FT).  MAX 7
C          VALUES (ONE FOR EACH MATERIAL).  SUBSCRIPT IS MATERIAL NUMBER.
C ASM    = AREA OF EACH MATERIAL CURRENTLY SMOLDERING (FT*FT)
C ISTATE = PACKED ARRAY CONTAINING DATA ON STATES OF INDIVIDUAL LINING
C          SURFACE ELEMENTS.  FIRST SUBSCRIPT IS ELEMENT I INDEX, SECOND
C          IS J INDEX.  ISTATE IS PACKED AS SHOWN
C
C               ISTATE = ITFPC*1000 + ISTP*10 + IST
C
C          ITFPC = FRACTION*1000 OF THIS ELMNT THAT HAS BEEN CONSUMED
C                  BY FLAMING OR SMLDRNG COMBUSTION.
C                  EX:  ITFPC = 400 => ELMNT IS 40% CONSUMED.
C          ISTP  = STATE OF THIS ELMNT DURING LAST PASS THRU FLAME SPRD
C                  CALCULATIONS.  VALUE = 1 THRU 7.
C          IST   = PRESENT STATE OF THIS ELMNT.  VALUE = 1 THRU 7.
C ISTATS = PACKED ARRAY CONTAINING DATA ON STATES OF SINGLE SEAT SURFACE
C          ELMNTS.  FIRST SUBSCRIPT = SEAT SURF I INDEX, SECOND SBSCRPT =
C          SEAT SURF J INDEX, THIRD SUBSCRIPT = SEAT GROUP NUMBER.
C          PACKING AND CONTENTS SAME AS FOR ISTATE SHOWN ABOVE.
C IWORD  = PACKED ARRAY CONTAINING DATA ON INDIVIDUAL LINING SURFACE
C          ELMNTS.  SUBSCRIPTING IS SAME AS ISTATE.  IWORD IS PACKED AS
```

```
C           SHOWN:
C
C                   IWORD = ITY*10000+ITX
C
C           ITX    = TIME IN INTEGER SECONDS THAT ELMNT HAS BEEN IN ITS
C                    CURRENT STATE. MAXIMUM VALUE 9999 SEC.
C           ITY    = A FLAG USED TO IDENTIFY ELMNTS AS CANDIDATES FOR
C                    STATE TRANSITION ON THE NEXT FLAME SPREAD PASS.
C IWORDS = PACKED ARRAY CONTAINING DATA ON INDIVIDUAL SEAT SURFACE
C          ELMNTS. SUBSCRIPTING IS SAME AS ISTATS AND PACKING AND
C          CONTENTS SAME AS IWORD.
C NFLM   = TOTAL NUMBER OF FLAMING ELMNTS OF EACH MATL TYPE.  SUBSCRIPT
C          IS MATERIAL NUMBER.
C NPYR   = TOTAL NUMBER OF SMOLDERING ELMNTS OF EACH MATL TYPE, SUBSCRIPT
C          IS MATERIAL NUMBER.
C RGS    = CONTAINS RATE OF GAS GENERATION BY SMOLDERING MATERIALS.
C          FIRST SUBSCRIPT IS THE GAS TYPE ID NUMBER, SECOND IS THE
C          MATERIAL NUMBER.  UNITS ARE LBM/(FT*FT*SEC).
C RSS    = CONTAINS RATE OF SMOKE GENERATION BY SMOLDERING MATERIALS.
C          SUBSCRIPT IS MATL NUMBER. UNITS ARE PART/(FT*FT*SEC).
C TOTGAS = TOTAL, OVER ALL MATERIAL TYPES, RATE OF GAS EMISSION
C          SUBSCRIPT IS GAS SPECIE NUMBER.  UNITS ARE LBM/SEC.
C TOTSEM = TOTAL RATE OF SMOKE EMISSION IN PARTICLES/SEC.
C TRGF   = TOTAL (OVER ALL MATERIAL TYPES) RATE OF GAS EMISSION FROM
C          ELEMENTS IN THE FLAMING STATE.  SUBSCRIPT IS SPECIE NUMBER.
C          UNITS ARE LBM/(SEC*SEC).
C TRGS   = TOTAL, OVER ALL MATERIAL TYPES, RATE OF GAS EMISSION FROM
C          ELEMENTS IN THE SMOLDERING STATE.  SUBSCRIPT IS SPECIE NUMBER.
C          UNITS ARE LBM/(SEC*SEC).
C TRSF   = TOTAL RATE OF SMOKE EMISSION BY ELEMENTS IN THE FLAMING STATE
C          UNITS ARE PARTICLES/(SEC*SEC).
C TRSS   = TOTAL RATE OF SMOKE EMISSION BY ELMNTS IN THE SMOLDERING
C          STATE. UNITS ARE PARTICLES/(SEC*SEC).
C NCE    = NUMBER OF CHARRED ELMNTS ON THE SURF GIVEN BY THE SUBSCRIPT
C VITNR  = RATE OF OXYGEN CONSUMPTION (TEMP VARIABLE FOR SUMMATION USE)
C TOTVIT = TOTAL RATE OF OXYGEN CONSUMPTION BY ALL FIRES, LBM/SEC
C RADFIR = FRACTION OF HEAT OF COMBUSTION RELEASED BY A FIRE THAT IS
C          FLAME RADIATION.  SUBSCRIPT IS FIRE NUMBER.
C ACM    = TOTAL AREA OF EACH MATERIAL IN CHARRED STATE, SUBSCRIPT IS
C          MATERIAL NUMBER.  UNITS FT*FT.
C AF     = FIRE BASE AREAS (FT*FT), SUBSCRIPT IS FIRE NUMBER.
C AFI    = BASE AREA OF THE IGNITION SOURCE FIRE (FT*FT).
C AEXP   = DIFFERENCE IN BASE AREA BETWEEN THE IGNITION SOURCE FIRE
C          AND ANY LARGER FIRE WHICH MAY SURROUND AND CONTAIN IT.
C COMB   = COMBUSTION ZONE HEIGHT FOR EACH FIRE, SEE SUBR ATMOS.  SUBSCR
C          IS FIRE NUMBER
C DQK    = HEAT RELEASE RATE (BTU/FT*FT*SEC) FOR A FIRE
C FLML   = FLAME LENGTH OF A FIRE.  SUBSCR IS FIRE NUMBER (FT)
C FSN1   = COUNTER OF NUMBER OF FLAMING ELMNTS ON SEAT GRP SURF 1.
C FSN2   = COUNTER OF NUMBER OF FLAMING ELMNTS ON SEAT GRP SURFS 2,3,4,5
C FSN3   = COUNTER OF NUMBER OF FLAMING ELMNTS ON SEAT GRP SURFS 6,7
C GAMMA  = STOICHIOMETRIC OXYGEN-TO-FUEL RATIO FOR A FIRE = SUBSCR NO.
C IBURN  = A FLAG TO INDICATE STATUS OF THE IGN SRC FIRE
C IF     = ARRAY CONTAINING INFO ON LINING SURFACE ELMNTS.  SEE SUBR FIRE
C IGMNI  = MINIMUM I INDEX VALUE FOR ELMNTS OF IGNITION SOURCE FIRE
C IGMNJ  = MINIMUM J INDEX VALUE FOR ELMNTS OF IGNITION SOURCE FIRE
C IGMXI  = MAXIMUM I INDEX VALUE FOR ELMNTS OF IGNITION SOURCE FIRE
C IGMXJ  = MAXIMUM J INDEX VALUE FOR ELMNTS OF IGNITION SOURCE FIRE
C IGNFIR = FLAG SIGNALING STATUS OF THE IGN SRC FIRE
C          IGNFIR=0 => IGN SRC FIRE IS OUT, =1 => IGN FIRE IS BURNING
C          BUT NOT YET DISCOVERED BY SUBR FIRE, =2 => IGN FIRE BURNING
```

```
C             AND HAS BEEN DISCOVERED.
C IGNIJ  = ARRAY CONTAINING I AND J INDICES OF IGN SRC ELMNTS. FIRST
C             SUBSCRIPT: 1 => VALUE IS I INDEX, 2 => VALUE IS J INDEX;
C             SECOND SUBSCR = ELMNT NUMBER, MAX 100 ELMNTS.
C IGSN    = SURFACE NUMBER ON WHICH IGN SRC LIES.
C ISFIRE = SEAT GROUP NUMBER ON WHICH A FIRE IS LOCATED. FIRE NUMBER IS
C             GIVEN BY THE VALUE OF THE SUBSCRIPT.
C IVMAX   = MAXIMUM VALUE OF THE ELMNT I INDEX OF THE ELMNTS WHICH
C             COMPOSE THE BASE OF A FIRE.  SUBSCRIPT IS THE FIRE NUMBER.
C IVMIN   = MINIMUM VALUE OF THE ELMNT I INDEX OF THE ELMNTS WHICH
C             COMPOSE THE BASE OF A FIRE.  SUBSCRIPT IS THE FIRE NUMBER.
C IVMN    = MIN I INDEX OF THE BASE ELMNTS OF A FIRE. THIS IS A
C             TEMPORARY VRBL WITH THE SAME FUNCTION AS IVMIN BUT WITHOUT
C             SUBSCRIPTS.  USED WITHIN THE FIRE LOOP OF THE MAIN PGM.
C IVMX    = MAX I INDEX OF THE BASE ELMNTS OF A FIRE - SEE ABOVE.
C IXFIRE = FLAG USED TO PASS INFORMATION ABOUT FIRES ON SEAT SURFACES
C             FROM SUBR FIRE TO SUBRS FCONS AND PVOLS. SEE SUBR FIRE FOR
C             FULL DEFINITION.
C IZONE   = ARRAY OF FLAGS INDICATING THE ZONE IN WHICH THE MAJORITY OF
C             A FIRE BASE AREA LIES. FIRE NUMBER IS GIVEN BY THE SUBSCRIPT
C             VALUE. IZONE = 2 => BASE IN UPPER ZONE, =1 => BASE IN LWR ZN.
C JVMAX   = MAXIMUM VALUE OF THE ELMNT J INDEX OF THE ELMNTS WHICH
C             COMPOSE THE BASE OF A FIRE.  SUBSCRIPT IS THE FIRE NUMBER.
C JVMIN   = MINIMUM VALUE OF THE ELMNT J INDEX OF THE ELMNTS WHICH
C             COMPOSE THE BASE OF A FIRE.  SUBSCRIPT IS THE FIRE NUMBER.
C JVMN    = MIN J INDEX OF THE BASE ELMNTS OF A FIRE. A TEMPORARY VRBL
C             WITH SAME FUNCTION AS JVMIN USED WITHIN THE FIRE LOOP
C             IN THE MAIN PGM.
C JVMX    = MAX J INDEX OF THE BASE ELMNTS OF A FIRE. A TEMPORARY VRBL
C             WITH THE SAME FUNCTION AS JVMAX USED WITHIN THE FIRE LOOP.
C K       = INTEGER INDEX IDENTIFYING EACH INDIVIDUAL GROUP OF ADJACENT
C             FLAMING ELMNTS WHICH FORM THE BASE OF A FIRE, THE FIRE
C             NUMBER.
C NFE     = NUMBER OF FLAMING ELMNTS ON THE SURFACE GIVEN BY THE VALUE
C             OF THE SUBSCRIPT.
C NFIRES = THE TOTAL NUMBER OF CURRENT ACTIVE FIRES.
C NIJC    = NUMBER OF CHARRED (AND THEREFORE INERT) ELMNTS TO BE
C             SPECIFIED AT THE START OF A RUN. SEE SUBR INPUTO.
C NIJSG   = NUMBER OF IGN SRC ELMNTS TO BE SPECIFIED IN THE INPUT.
C             SEE SUBR INPUTO.
C NPE     = NUMBER OF SMOLDERING ELMNTS ON THE SURFACE GIVEN BY THE VALUE
C             OF THE SUBSCRIPT.
C NSFL    = ARRAY CONTAINING THE NUMBER OF FLAMING ELMNTS ON EACH OF THE
C             SEVEN SURFACES OF A SEAT GROUP. SUBSCRIPT VALUE IS THE SEAT
C             NUMBER. ARRAY IS USED AND RESET IN THE FIRE LOOP FOR EACH
C             SEAT GROUP.
C OMEGA   = ARRAY OF INVERSE VOLUMETRIC EXPANSION RATIOS FOR THE FLAME
C             REGIONS OF EACH FIRE. SUBSCRIPT IS FIRE NUMBER. OMEGAS ARE
C             COMPUTED IN SUBR SCAN AND PASSED TO SUBR ATMOS FOR LATER USE.
C PDH     = SMOLDERING RANGE OF A FIRE (FT)  SEE EQ 4-4 (P32) OF [1].
C             USED WITHIN THE FIRE LOOP SO THAT NO SUBSCRIPT IS NEEDED.
C PIGN    = PERIMETER LENGTH OF THE IGN SRC FIRE (FT)
C RF      = RATE OF FLAME SPREAD ON A CABIN LINING SURFACE  (FT/SEC)
C             FIRST SUBSCRIPT IS THE LINING SURF NUMBER, SECOND INDICATES
C             THE SPREAD DIRECTION WRT THE I AND J DIRECTIONS.
C              VALUE = 1 => NEG J DIRECTION
C              VALUE = 2 => POS J DIRECTION
C              VALUE = 3 => NEG I DIRECTION
C              VALUE = 4 => POS I DIRECTION
C RFS     = RATE OF FLAME SPREAD ON SEAT SURFACES (FT/SEC). FIRST SUBSCR
C             IS SEAT SURF NUMBER, SECOND IS SPREAD DIRECTION GIVEN AS FOR
```

```
C            RF ABOVE.
C RFWS    = RATE (FT/SEC) OF FLAME SPREAD BETWEEN SEATS AND SIDEWALLS.
C RGF     = ARRAY OF RATES OF GAS RELEASE (LBM/(FT*FT*SEC)) FOR EACH MATL
C            FIRST SUBSCRIPT IS GAS NUMBER, SECOND IS MATL NUMBER.
C RGFK    = TOTAL RATE OF GAS RELEASE (LBM/SEC) FOR A GIVEN FIRE. SUBSCR
C            IS GAS NUMBER.
C RHOZ    = ARRAY OF FUEL VAPOR DENSITIES FOR EACH FIRE (LBM/(FT*FT*FT))
C            SUBSCRIPT IS FIRE NUMBER.
C RSF     = ARRAY OF CURRENT SMOKE GENERATION RATES
C            (PARTICLES/(FT*FT*SEC)) FOR EACH MATL WHEN IN THE FLAMING
C            STATE. SUBSCR IS MATL NUMBER.  SEE SUBR RATES.
C RSFK    = TOTAL SMOKE GENERATION RATE (PARTICLES/SEC) FOR A GIVEN FIRE.
C TDG     = TOTAL RATE OF HEAT RELEASE BY ALL INTERIOR FIRES (BTU/SEC).
C TBURNI  = TOTAL TIME TO BURN FOR IGNITION SRC FIRE (SEC)
C UZ      = ARRAY OF FUEL VAPOR VELOCITIES AT THE BASE OF A GIVEN FIRE
C            (FT/SEC).  SUBSCRIPT IS FIRE NUMBER.
C YZ      = ARRAY OF FIRE BASE AREA (EQUIVALENT) RADII (FT).  SUBSCRIPT
C            IS FIRE NUMBER.
C ZB      = ARRAY OF DISPLACEMENTS FROM FLOOR OF FIRE BASE AREAS (FT).
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1             IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2             RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3             TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4             ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5             FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6             IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7             IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8             JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9             NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1             RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2             TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3             FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4             TP(7),TPC(7)
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'GASES':
C
C CHIL    = ARRAY OF MASS FRACTIONS OF GAS SPECIES IN LWR ZONE, FIRST
C            SUBSCR IS GAS NO, SECOND IS COMP NO.
C CHIU    = ARRAY OF MASS FRACTIONS OF GAS SPECIES IN UPR ZONE, FIRST
C            SUBSCR IS GAS NO, SECOND IS COMP NO.
C CP      = CONSTANT PRESSURE HEAT CAPACITY OF CABIN GASES (BTU/LBM*R)
C JCOR    = CORRESPONDENCE ARRAY FOR SCALING
C NGAS    = ARRAY OF ALPHANUMERIC (CHARACTER) NAMES OF GAS SPECIES,
C            SUBSCR IS GAS NO.
C NSPCS   = TOTAL NUMBER OF SPECIES (INCLUDING SMOKE)
C PAMB    = AMBIENT DENSITY AT CABIN FLOOR LEVEL (LBM/(FT*SEC*SEC))
C PF      = ARRAY OF PRESSURES AT THE FLOOR OF EACH COMPARTMENT, SUBSCR
C            IS COMP NO. (LBM/(FT*SEC*SEC))
C RHOAM   = AMBIENT DENSITY (LBM/(FT*FT*FT))
C RHOL    = ARRAY OF DENSITIES OF THE LWR ZONE, SUBSCR IS COMP NO.
C            (LBM/(FT*FT*FT))
C RHOU    = ARRAY OF DENSITIES OF THE UPR ZONE, SUBSCR IS COMP NO.
C            (LBM/(FT*FT*FT))
C TAM     = AMBIENT TEMPERATURE (R)
C TL      = ARRAY OF LOWER ZONE TEMPERATURES, SUBSCR IS COMP NO.  (R)
C TU      = ARRAY OF UPPER ZONE TEMPERATURES, SUBSCR IS COMP NO.  (R)
C TWO     = ARRAY OF SCALE FACTORS
C VOLL    = ARRAY OF LOWER ZONE VOLUMES, SUBSCR IS COMP NO.  (FT*FT*FT)
C VOLU    = ARRAY OF UPPER ZONE VOLUMES, SUBSCR IS COMP NO.  (FT*FT*FT)
C WMOLEC  = ARRAY OF GAS SPECIES MOLECULAR WEIGHTS (LBM/LBMOLE)
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C XTHEN  = ARRAY FOR STORAGE OF GAS VARIABLES AT THE PREVIOUS TIME STEP.
C ZD     = ARRAY OF THERMAL DISCONTINUITY POSITIONS (LOWER ZONE
C          THICKNESSES), SUBSCR IS COMP NO. (FT)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1            RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2            VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3            JCOR(120)
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'GMTRY':
C
C IMATL  = MATERIAL ID NUMBER FOR CABIN LINING SURFACE GIVEN BY VALUE OF
C          SUBSCRIPT. MAX 20 VALUES, ONE PER LINING SURFACE.
C IMATS  = MATERIAL ID NUMBER FOR SEAT SURFACE GIVEN BY SUBSCRIPT. MAX
C          7 VALUES, ONE PER SEAT SURFACE.
C IMTLP  = MATERIAL ID NUMBER FOR CABIN PARTITION GIVEN BY VALUE OF
C          SUBSCRIPT.  MAX 4 VALUES.
C IMAX   = MAXIMUM VALUE OF ELEMENT I INDEX ON SURFACE NUMBER GIVEN BY
C          VALUE OF SUBSCRIPT.
C IMIN   = MINIMUM VALUE OF ELEMENT I INDEX ON SURFACE NUMBER GIVEN BY
C          VALUE OF SUBSCRIPT.
C IRAY   = LINING SURFACE NUMBER ON WHICH AN ELEMENT LIES WHOSE I INDEX
C          EQUALS THE VALUE OF THE SUBSCRIPT.
C IRAYS  = SEAT SURFACE NUMBER ON WHICH AN ELEMENT LIES WHOSE I INDEX
C          EQUALS THE VALUE OF THE SUBSCRIPT.
C JMAX   = MAXIMUM VALUE OF ELMNT J INDEX ON SURFACE GIVEN BY VALUE OF
C          JMAX'S SUBSCRIPT. MAX VALUE OF JMAX IS 15, MINIMUM 1.
C JMIN   = MINIMUM VALUE OF ELMNT J INDEX ON SURFACE GIVEN BY VALUE OF
C          JMIN'S SUBSCRIPT. MAX VALUE OF JMIN IS 15, MINIMUM 1.
C LSN    = TOTAL NUMBER OF CABIN LINING SURFACES (FLOOR,SIDEWALLS, ETC )
C          MAX VALUE = (30-(NUMBER OF SEAT GROUPS))
C MAXELI = MAXIMUM VALUE OF ELMNT I INDEX OVERALL,= HIGHEST I INDEX ON
C          HIGHEST NUMBER LINING SURFACE.
C NCOMPS = NUMBER OF COMPARTMENTS, MAX = 4, MIN = 1
C NS     = TOTAL NUMBER OF LINING SURFACES + SEAT GROUPS. MAX VALUE = 30
C CH     = CABIN FLOOR TO CEILING HEIGHT (FT).
C CL     = CABIN COMPARTMENT LENGTHS (FT), MAX = 4
C CNCTNS = ARRAY INDICATING CONNECTIONS BETWEEN COMPARTMENTS BY VENTS
C CW     = CABIN WIDTH AT FLOOR (FT).
C DWS    = DISTANCE (FT) FROM SEATS TO SIDEWALL (SEAT GROUPS NEAREST
C          SIDEWALL)
C FHMIN  = MINIMUM FLOOR TO CEILING OR HATRACK DISTANCE (FT)
C FLOW   = FORCED FLOW RATE (CFM) THRU VENT GIVEN BY SUBSCRIPT VALUE
C HSTS   = HEIGHT OF TOP OF SEATS ABOVE FLOOR (FT)
C IARX   = INDICATES POSITION OF SEAT GRPS WRT FLOOR. SEE SUBR INIT2 FOR
C          FULL DEFINITION.
C IARY   = INDICATES POSITION OF OVERHEAD SURFACES WRT FLOOR  SEE SUBR
C          INIT2 FOR FULL DEFINITION.
C ICLL   = SURFACE NUMBER OF LEFTMOST CEILING SURFACE
C ICLR   = SURFACE NUMBER OF RIGHTMOST CEILING SURFACE
C IEND   = HIGHEST I INDEX VALUE ON CURRENT SURF. SEE SUBR FIRE
C IFRCMP = NUMBER OF COMPARTMENT WITH INTERIOR FIRE
C IFIRL  = I INDEX OF SIDEWALL ELMNTS NEAREST TOP OF SEATS ON LEFT SIDE
C          OF CABIN
C IFIRR  = I INDEX OF SIDEWALL ELMNTS NEAREST BOTTOM OF SEATS ON RIGHT
C          SIDE OF CABIN
C ILSTL  = I INDEX OF SIDEWALL ELMNTS NEAREST BOTTOM OF SEATS ON LEFT
C          SIDE OF CABIN
C ILSTR  = I INDEX OF SIDEWALL ELMNTS NEAREST TOP OF SEATS ON RIGHT SIDE
C          OF CABIN
C INTO   = VALUE IS COMPARTMENT NUMBER INTO WHICH FORCED FLOW OCCURS
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C IONE   = I INDEX OF FLOOR ELMNT DIRECTLY UNDER THE FORWARD LEFT CORNER
C          OF THE SEAT GROUP GIVEN BY THE SUBSCRIPT VALUE
C ISSWLI = ARRAY OF I VALUES OF SIDEWALL ELMNTS NEAREST A GIVEN SEAT
C          GROUP. SEE SUBR INIT2 FOR FULL DEFN.
C ISSWLJ = ARRAY OF J VALUES OF SIDEWALL ELMNTS NEAREST A GIVEN SEAT
C          GROUP  SEE SUBR INIT2 FOR FULL DEFN.
C ISSWRI = ARRAY OF I VALUES OF SIDEWALL ELMNTS NEAREST A GIVEN SEAT
C          GROUP. SEE SUBR INIT2 FOR FULL DEFN.
C ISSWRJ = ARRAY OF J VALUES OF SIDEWALLL ELMNTS NEAREST A GIVEN SEAT
C          GROUP. SEE SUBR INIT2 FOR FULL DEFN.
C ISWSL  = ARRAY GIVING POSITION OF LEFT-MOST SEAT GROUPS WRT LEFT
C          SIDEWALL. SEE SUBR INIT2 FOR FULL DEFN.
C ISWSR  = ARRAY GIVING POSITION OF RIGHT-MOST SEAT GROUPS WRT RIGHT
C          SIDEWALL. SEE SUBR INIT2 FOR FULL DEFN.
C ISTART = LOWEST I INDEX ON CURRENT SURFACE. SEE SUBR FIRE.
C NPROJ  = FLAG TO INDICATE PRESENCE (VALUE =1) OR ABSENCE (VALUE =0) OF
C          A HATRACK
C IPJUL  = SURF NUMBER OF LINING SURFACE WHICH FORMS THE TOP OF THE LEFT
C          HATRACK.
C IPJLL  = SURF NUMBER OF LINING SURFACE WHICH FORMS THE BOTTOM OF THE
C          LEFT HATRACK.
C IPJUR  = SURF NUMBER OF LINING SURFACE WHICH FORMS THE TOP OF THE
C          RIGHT HATRACK
C IPJLR  = SURF NUMBER OF LINING SURFACE WHICH FORMS THE BOTTOM OF THE
C          LEFT HATRACK
C JEND   = HIGHEST J INDEX VALUE ON CURRENT SURFACE. SEE SUBR FIRE.
C JONE   = J INDEX OF FLOOR ELMNT DIRECTLY UNDER THE FORWARD LEFT CORNER
C          OF THE SEAT GROUP GIVEN BY THE SUBSCRIPT VALUE.
C JSTART = LOWEST J INDEX ON THE CURRENT SURFACE. SEE SUBR FIRE.
C NJS    = MAXIMUM VALUE OF THE ELMNT J INDEX ON SEATS. SET TO THE FIXED
C          VALUE OF 22 IN SUBR INPUTO AS SEATS HAVE A STANDARD SHAPE.
C NSG    = TOTAL NUMBER OF SEAT GROUPS IN CABIN SECTION. MAXIMUM VALUE
C          IS 9
C NV     = NUMBER OF VENTS
C SGWD   = ARRAY OF SEAT GROUP WIDTHS (FT). SUBSCRIPT IS SEAT GROUP NO.
C SL     = DETAILED SECTION (PART OF CABIN WHERE FIRE IS TRACKED)
C          LENGTH (FT) (NOT USED IN VER 3)
C SWD    = CABIN LINING SURFACE WIDTH (FT) SEE USER'S GUIDE [2] FOR FULL
C          DEFINITION.  SUBSCRIPT IS SURFACE NUMBER.
C SX     = ARRAY OF X COORDS OF LINING SURFACE EDGES
C SZ     = ARRAY OF Z COORDS OF LINING SURFACE EDGES
C VN     = ARRAY OF SURFACE NORMAL VECTORS TO CABIN LINING SURFACES
C          FIRST SUBSCRIPT IS THE SURF NUMBER, SECOND SPECIFIES THE
C          COMPONENT AS SHOWN: 1 => X, 2 => Y, 3 => Z.
C VENTH  = ARRAY OF VENT HEIGHT DIMENSIONS (FT). SUBSCR IS VENT NUMBER.
C VENTW  = ARRAY OF VENT WIDTHS (FT). SUBSCRIPT IS VENT NUMBER.
C VENTT  = ARRAY OF DISTANCES (FT) FROM FLOOR TO TOP EDGE OF EACH VENT
C          SUBSCRIPT IS VENT NUMBER.
C VTOTAL = TOTAL VOLUME (CU FT) OF COMPARTMENT GIVEN BY SUBSCRIPT
C XMN    = ARRAY OF MINIMUM DISTANCES OF A LINING SURFACE FROM THE FLOOR
C          (FT).  SUBSCRIPT IS SURFACE NUMBER.
C XMX    = ARRAY OF MAXIMUM DISTANCES OF A LINING SURFACE FROM THE FLOOR
C          (FT).  SUBSCRIPT IS SURFACE NUMBER.
C XCOR   = ARRAY OF X COORDINATES OF LEFTHAND FORWARD CORNER OF SEAT
C          GROUP (FT)
C YCOR   = ARRAY OF Y COORDINATES OF LEFTHAND FORWARD CORNER OF SEAT
C          GROUP (FT)
C Z      = ARRAY OF DISPLACEMENTS (FT) OF CABIN SURFACES FROM FLOOR.
C          SUBSCRIPT IS SURFACE NUMBER. SEE USER'S GUIDE OF [2] FOR
C          FULL DEFINITION.
C SSGWD  = WORKING VARIABLE STORING SUM OF WIDTH OF ALL SEAT GROUPS
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C          USED IN SEAT VOLUME CORRECTIONS IN SUBR ATMOS.
C TVSG    = TOTAL VOLUME (FT*FT*FT) OF ALL SEAT GROUPS. (NOT USED)
C HT1     = DISTANCE FROM THE CABIN CEILING TO THE TOP OF THE SEAT
C           BACKRESTS (FT). (NOT USED IN VERSION 3)
C HT2     = DISTANCE FROM THE CABIN CEILING TO THE TOP OF THE SEAT
C           CUSHIONS (FT). (NOT USED IN VERSION 3)
C HT3     = DISTANCE FROM THE CABIN CEILING TO THE BOTTOM OF THE SEAT
C           CUSHIONS (FT). (NOT USED IN VERSION 3)
C HT4     = ARRAY OF THE DISTANCES FROM THE CABIN CEILING TO THE TOP EDGE
C           OF EACH VENT (FT). (NOT USED IN VERSION 3)
C NSSTS   = NUMBER OF SEAT SURFACES, FIXED TO VALUE OF 7
C SLSW    = (NOT USED IN VERSION 3)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1            IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2           CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3           ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4            ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5            ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6            IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7            SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8            XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9            HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1            CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2            FHMIN
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'MATLS':
C
C TABX    = TABLE OF RADIATION VALUES FOR MATERIAL PROPERTIES.
C           FIRST SUBSCRIPT IS THE PROPERTY ID, SECOND IS THE MATERIAL
C           NUMBER, THIRD IS THE NUMBER OF THE ENTRY (MAX OF SIX ENTRIES)
C           PROPERTY NUMBERING IS AS SHOWN:
C            1=HORIZONTAL FLAME SPREAD RATE, 2=UPWARD FLAME SPRD RATE
C            3=DOWNWARD FLAME SPRD RATE,  4= TIME TO IGNITE,
C            5=RATE OF HEAT RELEASE, 6=RATE OF SMOKE RELEASE (FLAMING),
C            7=TIME TO STOP PYROLYZING WHEN INPUT RADIATION REMOVED,
C            8=TIME TO BURN OUT FROM FLAMING STATE
C            9=RELEASE RATE (FLAMING) OF FIRST GAS SPECIE,
C           10=RELEASE RATE (FLAMING) OF SECOND GAS SPECIE,... AND SO ON
C            THRU 18=RELEASE RATE (FLAMING) OF THE 10TH GAS SPECIE.
C TABY    = TABLE OF PROPERTY VALUES CORRESPONDING TO THE RADIATION VALUE
C           IN TABX. SUBSCRIPTING IS SAME AS TABX. SEE [1] FOR UNITS OF
C           INDIVIDUAL PROPERTIES.
C NTXG    = NUMBER OF GAS SPECIES (NOT INCLUDING O2 OR N2)
C FOXI    = OXYGEN CONSUMPTION FACTOR FOR IGN SRC FUEL
C RADTAB  = FRACTION OF HEAT OF COMBUSTION OF A MATL THAT IS RELEASED AS
C           FLAME RADIATION. SUBSCRIPT IS MATERIAL NUMBER.
C RADI    = FRACTION OF HEAT OF COMBUSTION OF IGN SRC FUEL THAT IS
C           RELEASED AS FLAME RADIATION.
C FOX     = OXYGEN CONSUMPTION FACTOR FOR EACH MATL
C           SUBSCRIPT IS MATL NUMBER.
C NMATLS  = NUMBER OF MATERIALS, MAXIMUM = 7.
C DGI     = HEAT RELEASE RATE (BTU/FT*FT*SEC) FOR IGNITION SOURCE FIRE
C DGM     = HEAT RELEASE RATE (BTU/FT*FT*SEC) FOR A MATL (CURRENT VALUE)
C           SUBSCR IS MATL NUMBER
C GAMI    = STOICHIOMETRIC OXYGEN-TO-FUEL RATIO FOR THE IGN SRC FUEL
C GTAB    = STOICHIOMETRIC OXYGEN-TO-FUEL RATIO FOR MATL = SUBSCR NO.
C ITF     = ARRAY OF TIMES-TO-IGNITE IN INTEGER SECONDS FOR LINING SURFS
C           SUBSCRIPT IS SURFACE NUMBER
C ITFC    = ARRAY OF TIMES-TO-BURN-OUT FROM FLAMING STATE FOR LINING
C           SURFACES. VALUE IN INTEGER SECONDS. SUBSCR IS SURF NUMBER.
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C ITFCS  = ARRAY OF TIMES-TO-BURN-OUT FROM FLAMING STATE FOR SEAT
C          SURFACES. VALUE IN INTEGER SECONDS. SUBSCR IS SURF NUMBER.
C ITFS   = ARRAY OF TIMES-TO-IGNITE IN INTEGER SECONDS FOR SEAT SURFACES
C          SUBSCRIPT IS SEAT SURFACE NUMBER.
C ITP    = ARRAY OF TIMES-TO-START-SMOLDERING IN SECONDS FOR LINING
C          SURFACES. SUBSCRIPT IS SURFACE NUMBER.
C ITPC   = ARRAY OF TIMES-TO-SMOLDER-OUT IN SECONDS FOR LINING SURFACES
C          SUBSCRIPT IS SURFACE NUMBER.
C ITPCS  = ARRAY OF TIMES-TO-SMOLDER-OUT IN SECONDS FOR SEAT SURFACES
C          SUBSCRIPT IS SEAT SURFACE NUMBER.
C ITPE   = ARRAY OF "SMOLDERING LAG" TIMES (TIME TO STOP SMOLDERING
C          AFTER EXTERNAL HEAT SOURCE IS REMOVED) IN SECONDS FOR LINING
C          SURFACES.  SUBSCRIPT IS SURFACE NUMBER.
C ITPES  = ARRAY OF SMOLDERING LAG TIMES IN SECONDS FOR SEAT SURFACES
C          SUBSCRIPT IS SURFACE NUMBER.
C ITPS   = ARRAY OF TIMES-TO-START-SMOLDERING IN SECONDS FOR SEAT
C          SURFACES.  SUBSCRIPT IS SEAT SURFACE NUMBER.
C QCI    = HEAT RELEASE RATE (BTU/(FT*FT*SEC)) FOR FIRE OF THE IGN SRC
C          FUEL.
C QP     = ARRAY OF THRESHOLD LEVELS OF RADIATION FOR TRANSITION OF A
C          MATERIAL TO THE SMOLDERING STATE (BTU/(FT*FT*SEC)).
C          SUBSCRIPT IS THE MATERIAL NUMBER.
C QTAB   = ARRAY OF HEATS OF COMBUSTION FOR CABIN MATERIALS (BTU/LBM)
C          SUBSCRIPT IS MATERIAL NUMBER
C RHOI   = IGN SRC FUEL VAPOR DENSITY (LBM/(FT*FT*FT)).
C RHOM   = ARRAY OF AVRG DENSITY OF CABIN INTERIOR MATLS(LBM/(FT*FT*FT))
C RSI    = SMOKE GENERATION RATE (PARTICLES/(FT*FT*SEC)) OF THE IGN SRC
C          FUEL.
C RTAB   = ARRAY OF FUEL VAPOR DENSITIES (LBM/(FT*FT*FT)) OF THE CABIN
C          MATERIALS. SUBSCRIPT IS MATL NUMBER.
C RTGI   = ARRAY OF GAS GENERATION RATES FOR THE IGN SRC FUEL
C          (LBM/(FT*FT*SEC)).  SUBSCR IS GAS SPECIE NUMBER.
C UTAB   = ARRAY OF MATLS FUEL VAPOR VELOCITIES AT FIRE BASE (FT/SEC)
C          SUBSCRIPT IS MATL NUMBER.
C XMFI   = TOTAL MASS OF IGNITION SOURCE FUEL (LBM)
C XMUI   = MASS BURNING RATE (LBM/(FT*FT*SEC)) OF IGN SRC FUEL.
C TSL    = ARRAY OF SURFACE TEMPERATURES OF CABIN LINING SURFACES (R)
C TSP    = ARRAY OF SURFACE TEMPERATURES OF CABIN PARTITIONS
C          (BULKHEADS) (R)
C CPM    = ARRAY OF AVERAGE HEAT CAPACITY OF MATERIALS (BTU/LBM*R)
C TKNS   = ARRAY OF LINING SURFACE MATERIALS THICKNESSES (FT)
C TKNSIN = ARRAY OF INSULATION THICKNESSES (FT)
C CNDCTY = ARRAY OF INSULATION THERMAL CONDUCTIVITY
C          (BTU/(FT-SEC-R))
C
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1              FOX(7),NMATLS,DQI,DQM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2              ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3              ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4              RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5              XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6              WMIGF,TKNSIN(7)
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'PARAMS':
C
C GRAV   = ACCELERATION OF GRAVITY, SET TO 32.174 FT/(S*S) IN INITLZ
C PI     = 3.1415927, SET IN SUBR INITLZ
C QTR    = 0.25, USEFUL CONSTANT SET IN INITLZ
C RGAS   = UNIVERSAL GAS CONSTANT, SET TO 1545 FT-LBF/(LBMOLE-R) IN
C          INITLZ
C SIGMA  = STEFAN-BOLTZMANN CONSTANT = 4.761E-13 BTU/(S-SQ FT-DEG R**4)
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C SGD     = ELEMENT DIMENSION = 0.5 FT
C THOU    = 1000, USED IN CONVERSIONS BETWEEN SECONDS AND MILLISECONDS
C TOL     = 0.00001, USED IN CONVERSION OF REALS TO INTEGERS
C EC      = ENTRAIMENT CONSTANT FOR COMBUSTION ZONE OF FIRE (NO UNITS).
C EP      = ENTRAINMENT CONSTANT FOR PLUME ZONE OF FIRE  (NO UNITS).
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
C
C-----------------------------------------------------------------------
C VARIABLES AND PARAMETERS IN COMMON 'RADTN':
C
C ALPC    = FLAME BASE CENTER EMITTANCE (NO UNITS)
C ABSCF   = FLAME ABSORPTION COEFFICIENT FOR EACH FIRE.  UNITS (1/FT)
C           MAXIMUM 30 VALUES, ONE PER FIRE.
C EB      = BLACKBODY RADIATION EMISSION POWER (BTU/FT*FT*SEC)
C QC      = AVERAGE LEVEL OF RADIATION REACHING CABIN SURFACES IN CONTACT
C           WITH THE UPPER ZONE GAS (SUBSCRIPT = 2) OR THE LOWER ZONE GAS
C           (SUBSCRIPT =1).  (BTU/(FT*FT*SEC)).
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
C-----------------------------------------------------------------------
C
C
C
C STATS IS THE ARRAY CONTAINING THE STATISTICS ON THE INTEGRATION OF THE
C GAS DYNAMICS EQUATIONS
C
      DIMENSION STATS(50,2)
      INTEGER ECOFLG
      TOL=0.00001
      NDXS = 0
C
C SET THE MAIN CLOCK, ITIME, TO 0 MILLISECONDS AND THE
C  FLAME SPREAD SECONDARY CLOCK, ITIM2, TO 0 MILLISECONDS.
      ITIME = 0
      ITIM2 = 0
C
C SUBR RDCNTL READS PROGRAM CONTROL DATA
C
      CALL RDCNTL
C
C SUBR RDGMTY READS DATA DESCRIBING THE CABIN GEOMETRY
C
      CALL RDGMTY
C
C SUBR RDMTLS READS DATA DESCRIBING THE CABIN MATERIALS
C
      CALL RDMTLS
C
C SUBR INITLZ INITIALIZES VARIABLES AND CONSTANTS
C
      CALL INITLZ
C
C SUBR RDIGTN READS DATA DESCRIBING THE IGNITION SCENARIO
C
      CALL RDIGTN
C
C SUBR ECHO PRINTS SELECTED INPUT DATA FOR VERIFICATION
C
      CALL ECHO
C
C IPR1    = FLAG FOR OUTPUT CONTROL, PRINTING OF ATMOSPHERE DATA
C IPR2    = FLAG FOR OUTPUT CONTROL, PRINTING OF FLAME SPREAD DATA
```

```
C
      IPR1=0
      IPR2=0
C
C THIS IS THE START OF THE PRIMARY LOOP OF THE PROGRAM
C ITIM2  = THE TIME IN MILLISECONDS AT WHICH THE NEXT PASS THRU THE
C          FLAME SPREAD CALCULATIONS IS TO BE MADE
C ITSPRD = THE TIME INCREMENT IN MILLISECONDS BETWEEN FLAME SPREAD
C          CALCULATIONS
C
 10   ITIM2=ITIM2+ITSPRD
C
C I      = SURFACE INDEX ( I=1 THRU 20 ARE LINING SURFS, 21 THRU 29
C          ARE SEAT GROUPS)
C K      = COUNTER FOR THE NUMBER OF SEPARATE FIRES FOUND ON A SURFACE
C KPR    = SAVES PREVIOUS VALUE OF K FOR COMPARISON LATER
C ISW    = A FLAG TO CONTROL CALLS TO SUBR RESET
C ISAVE  = A FLAG TO CONTROL CALLS TO SUBR SCAN FOR CONTINUED SCANNING
C          OF SURFACES FOR FIRES
C IGNFIR = A FLAG TO INDICATE STATUS OF THE IGNITION SOURCE FIRE
C
 20   I=0
      K=0
      KPR=0
      ISW=0
      ISAVE=0
      IGNFIR=0
      IF(IBURN.EQ.1) IGNFIR=1
C
C SET VARIABLES WHICH ACCUMULATE TOTAL RATES OF HEAT,SMOKE,AND GAS
C RELEASE AND OXYGEN CONSUMPTION
C
      TDQ=0.
      TRSF=0.
      TOTVIT=0.
      DO 23 IG=1,NTXG
 23   TRGF(IG)=0.
C
      DO 25 IM=1,NMATLS
 25   TDGMTL(IM) = 0.
C
C INCREMENT I => PROCEED TO NEXT SURFACE
C
 30   I=I+1
C
C IF THERE ARE CURRENTLY NO FLAMING ELEMENTS ON SURFACE I, SKIP SPREAD
C CALCULATIONS FOR THIS STEP
C
      IF(NFE(I).LE.0) GO TO 65
C
C SUBR SCAN SEARCHES SURFACE I FOR A GROUP OF ADJOINING FLAMING
C ELEMENTS, I.E. A FIRE. THIS SUBR WILL CHANGE VALUES OF ISAVE
C AND K THRU COMMON TO CONTROL THE AMOUNT OF SEARCHING DONE
C
 40   CALL SCAN(I)
C
C IF K=KPR NO NEW FIRES HAVE BEEN FOUND DURING THE LAST PASS THRU SCAN
C THEREFORE SKIP SPREAD CALCULATIONS.
C
      IF(K.EQ.KPR) GOTO 60
C
```

```
C SUBR RATES FINDS THE SPECIFIC VALUES OF THE MATERIALS PROPERTIES USING
C RADIATION LEVELS FOR THE FIRE JUST ISOLATED BY SUBR SCAN. VALUES ARE
C SUPPLIED TO LATER SUBROUTINES THRU COMMON
C
      CALL RATES(I)
C
C IF I > LSN THIS SURFACE IS A SEAT GROUP SURFACE AND CONTROL PASSES TO
C THE SPREAD CALCULATIONS FOR SEATS AT STMT 50
C
      IF(I.GT.LSN) GO TO 50
C
C SUBR COND COMPUTES THE FLAME SPREAD TO ADJACENT ELEMENTS ON THE
C LINING SURFACE I.
C
      CALL COND(I)
C
C SUBR FCON COMPUTES THE FLAME SPREAD TO ELEMENTS ON OTHER SURFACES
C TOUCHED BY FIRE FROM SURFACE I
C
      CALL FCON(I)
C
C SUBR PVOL COMPUTES THE SPREAD OF SMOLDERING REGIONS ON CABIN LINING
C SURFACE I.
C
      CALL PVOL(I)
C
C THIS ENDS CONSIDERATION OF SPREAD CAUSED BY FIRE K, SO SET KPR=K.
C
      KPR=K
      GO TO 55
C
C SUBR CONDS COMPUTES THE FLAME SPREAD TO ADJACENT ELEMENTS ON THE SEAT
C GROUP GIVEN BY I
C
 50   CALL CONDS(I)
C
C SUBR FCONS COMPUTES THE FLAME SPREAD TO ELEMENTS ON OTHER SURFACES
C DUE TO FIRE FROM THE SEAT GROUP GIVEN BY I.
C
      CALL FCONS(I)
C
C SUBR PVOLS COMPUTES THE SPREAD OF SMOLDERING REGIONS FROM THE SEAT
C GROUP GIVEN BY I
C
      CALL PVOLS(I)
C
C THIS ENDS CONSIDERATION OF SPREAD CAUSED BY FIRE K, SO SET KPR=K.
C
      KPR=K
C
C SUBR TEST HAS 3 FUNCTIONS: (1) DETECT ANY FLAMING ELEMENTS DUE TO BURN
C OUT NOW AND SET THEM TO THE CHARRED STATE, (2) UPDATE THE "FRACTION
C CONSUMED" VALUE, ITFPC, FOR ALL ELEMENTS CONTINUING TO BURN, AND
C (3) COMPUTE THE TOTAL RATES OF HEAT, SMOKE, AND GAS RELEASE AND OXYGEN
C CONSUMPTION.
C
 55   CALL TEST(I)
C
C IF ISAVE IS NOT ZERO THERE ARE ADDITIONAL FLAMING ELMNTS ON SURFACE I,
C SO RETURN TO SUBR SCAN TO ORGANIZE THEM
C
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```
 60    IF(ISAVE.NE.0) GO TO 40
C
C TEST TO FIND IF ALL SURFACES HAVE BEEN SEARCHED, IF NOT RETURN TO TOP
C OF THE LOOP
C
 65    IF(I.LT NS) GO TO 30
C
C SINCE ALL SEARCHING FOR FIRES IS NOW OVER RECORD THE TOTAL NUMBER OF
C SEPARATE FIRES (NOT COUNTING ANY NEW ONES STARTED BY SUBR COND, ETC)
C IN 'NFIRES'
C
 67    NFIRES=K
C
C SUBR ELEM HAS 4 FUNCTIONS: (1) UPDATE THE "FRACTION CONSUMED"
C VALUE, ITFPC, FOR SMOLDERING (STATE 2) ELMNTS, (2) DETECT ANY SMOL-
C DERING ELMNTS DUE TO TRANSITION TO STATE 4 OR 7 AND SET THEM SO, (3)
C RESET STATE 5 ELMNTS TO STATE 1 IF REQUIRED, (4) UPDATE "ELAPSED TIME
C IN STATE" VALUE, ITX, FOR ELMNTS IN STATES 2,5,AND 6.
C
 70    CALL ELEM
C
C IF SUBR ELEM IS CALLED SUBR RESET MUST BE USED LATER, SO SET ISW=1.
C
       ISW=1
C
C SUBR AFP COUNTS THE NUMBER OF ELMNTS NOW IN THE FLAMING, SMOLDERING,
C AND CHARRED STATES AND THE TOTAL AREA OF EACH MATERIAL TYPE
C NOW IN EACH OF THESE STATES
C
       CALL AFP
C
C SUBR ATMOS IS THE COMPLETE GAS DYNAMICS CALCULATION, GIVING UPDATED
C VALUES OF CABIN ATMOSPHERE TEMPERATURE, COMPOSITION, SMOKE CONCEN-
C TRATION,ETC. ATMOS IS CALLED AT EACH SMALL STEP, IDELT, OF THE RUN.
C
 80    CALL ATMOS(STATS,NDXS)
C
C SUBR SRFTMP UPDATES THE SURFACE TEMPERATURES OF THE CABIN MATERIALS
C
       CALL SRFTMP
C
C INCREMENT THE MAIN CLOCK, ITIME, BY THE SMALL TIME STEP
C
       ITIME = ITIME + IDELT
C
C IF THIS IS THE FIRST PASS ALWAYS CALL SUBR OUTPUT (PRIMARILY TO
C VERIFY INITIAL CONDITIONS)
C
       IF( ITIME .EQ. IDELT ) CALL OUTPUT(0,0,STATS,NDXS)
C
C SET THE OUTPUT CONTROL FLAGS USING IPEMS, IPSPR, IPAUX, AND ITIME.
C
       IPR1=MOD(ITIME,IPEMS)
       IPR2=MOD(ITIME,IPSPR)
       IPR3=MOD(ITIME,IPAUX)
C
C SUBR OUTPUT WRITES ALL FLAME SPREAD AND CABIN ATMOSPHERE QUANTITIES TO
C FORTRAN UNIT 6 AT THE CURRENT TIME. IPR1 AND IPR2 CONTROL WHAT INFO
C IS WRITTEN:
C         IPR1=0 => WRITE CABIN ATMOS. VARIABLES, OTHERWISE SKIP
C         IPR2=0 => WRITE FLAME SPREAD VARIABLES, OTHERWISE SKIP
```

```
C
 90   CALL OUTPUT(IPR1, IPR2, STATS, NDXS)
C
C SUBR AUXOUT WRITES SELECTED VARIABLES TO FORTRAN UNIT 8 FOR LATER USE,
C SUCH AS PLOTTING.  CALLS TO AUXOUT ARE CONTROLLED BY THE FLAG IPR3 SET
C UPSTREAM.
C
C     IF( IPR3 .EQ. 0 ) CALL AUXOUT
C
C TEST IF THE STOPPING TIME HAS BEEN REACHED, IF SO STOP.
C
      IF(ITIME.GE.ITFIN) GO TO 1000
C
C IF ISW IS NOT = 1 SKIP THE CALL TO SUBR RESET.
C
      IF(ISW.NE.1) GO TO 100
C
C SUBR RESET SETS THE "PAST" ELMNT STATE TO THE "PRESENT" STATE FOR ALL
C ELMNTS TO PREPARE FOR THE NEXT ROUND OF FLAME SPREAD COMPUTATIONS
C
      CALL RESET
      ISW=0
C
 100  CONTINUE
C
C SUBR RAMP COMPUTES THE PRODUCT RELEASE RATES FOR THE IGNITION SOURCE
C  FIRE DURING THE RAMP-IN PERIOD. DURING THIS PERIOD FLAME SPREAD
C  CALCS MUST BE DONE AT EACH SMALL TIME STEP.
C
      ITSPRD = IRATIO * IDELT
      DELTSP = ITSPRD / THOU
      IF (ITIME .GT. IRAMPT) GO TO 120
      ITSPRD = IDELT
      DELTSP = ITSPRD / THOU
      CALL RAMP
      IF( ITIME .GE. ITIM2 ) GO TO 10
      GO TO 20
C
C TEST TO SEE IF IT IS NOW TIME TO MAKE THE FLAME SPREAD CALCULATIONS,
C  IF SO TRANSFER TO THE TOP OF THE SPREAD LOOP
C
 120  IF( ITIME .GE. ITIM2 ) GO TO 10
C
C FLAME SPREAD CALCULATIONS ARE NOT SCHEDULED, SO RETURN TO THE CABIN
C  ATMOSPHERE SECTION
C
      GO TO 80
C
C WRITE THE COMPLETION MESSAGE AND STOP
C
 1000 WRITE(6,6)
 6    FORMAT(1H1//10X,21H**NORMAL COMPLETION**)
      STOP
      END
```

```
      SUBROUTINE RAMP
C
C ---------------------------------------------------------------------
C OBJECTIVE
C (1) THIS SUBR COMPUTES THE RATES OF HEAT, SMOKE, AND GAS RELEASE AND
C     OXYGEN CONSUMPTION FOR THE IGNITION SOURCE FIRE DURING THE
C     RAMP-IN PERIOD ( TIME = 0 THRU TIME = IRAMPT )
C ---------------------------------------------------------------------
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1              IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2              ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3              JCBSKP
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1              FOX(7), NMATLS, DQI, DQM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2              ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3              ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4              RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5              XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6              WMIGF, TKNSIN(7)
C
C FCTR CONVERTS THE OLD RATE VALUES FROM THE LAST TIME STEP TO THE
C  NEW VALUES FOR THE UPCOMING TIME STEP
C
      FCTR = FLOAT( IDELT ) / FLOAT( ITIME ) + 1.0
C
      DQI = DQI * FCTR
      RSI = RSI * FCTR
      DO 10 IG = 1, NTXG
 10   RTGI(IG) = RTGI(IG) * FCTR
      FOXI = FOXI * FCTR
C
      RETURN
C
      END
```

```
      SUBROUTINE RDGMTY
C ---------------------------------------------------------------------
C OBJECTIVE
C (1) READ IN VARIABLES DESCRIBING THE CABIN GEOMETRY AND INITIALIZE
C     SEVERAL ARRAYS OF GEOMETRIC INFORMATION.
C COMMENTS
C (2) SOME ERROR CHECKING OF THE INPUT IS DONE WITH SUBR ERROR.
C (3) INPUT DATA CARD TYPES AS IDENTIFIED BY THE DACFIR3 USER'S GUIDE
C     ARE SHOWN WITH THE CORRESPONDING READ STMTS.
C     SEE USER'S GUIDE AND/OR COMMON COMMENTS FOR DEFINITION OF VRBLS.
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
C
C READ CARD TYPE 4 - CABIN MAX CEILING HEIGHT, WIDTH AT FLOOR
C
      READ(5, 4) CH, CW
 4    FORMAT(8F10.1)
C
C READ CARD TYPE 5 - NUMBER OF COMPARTMENTS ( MAX VALUE = 4 ), AND
```

```
: COMPARTMENT NUMBER FOR INTERIOR FIRES
C
      READ(5,5) NCOMPS, IFRCMP
 5    FORMAT(16I5)
C
C READ CARD TYPE 6 - COMPARTMENT LENGTHS
C
      READ(5,6) (CL(I), I=1,NCOMPS)
 6    FORMAT(8F10.1)
C
C READ CARD TYPE 7 - NO. LINING SURFACES, NO. SEAT GROUPS, CEILING DEFN.
C
      READ(5,7) LSN, NSG, ICLL, ICLR
 7    FORMAT(16I5)
C
C TEST TO FIND IF MORE THAN 20 LINING SURFS WERE SPECIFIED.
C
      NERR=1
      IF(LSN.LE.20)GO TO 101
 100  CALL ERROR(NERR)
      STOP
 101  NERR=2
C
C TEST TO FIND IF MORE THAN 9 SEAT GROUPS WERE SPECIFIED.
C
      IF(NSG.GT.9)GO TO 100
      NERR=3
C
C TEST TO FIND IF THE NUMBER OF THE RIGHTMOST CEILING SURFACE IS,
C INCORRECTLY, GREATER THAN THE NUMBER GIVEN THE LEFTMOST SURFACE.
C RIGHT AND LEFT ARE DEFINED BY A VIEW LOOKING AFT.
C
      IF(ICLL.LE.ICLR)GO TO 100
C
C NS=LSN+NG : TOTAL NO OF SURFS = NO LINING SURFS + NO SEAT GROUPS
C NSSTS = 7 : NUMBER OF SEAT SURFACES = 7  (ALWAYS)
C NJS=22    : MAXIMUM VALUE OF J INDEX FOR SEAT ELEMENTS IS 22 (ALWAYS)
C SQD=0.5   : ELEMENTS ARE ALWAYS 0.5X0.5 FT SQUARE.
C HSTS=4.5  : TOTAL HEIGHT OF SEATS IS ALWAYS 4.5 FT.
C
      NS=LSN+NSG
      NSSTS=7
      NJS=22
      SQD=0.5
      HSTS=4.5
      SX(1) = 0.
      SZ(1) = 0.
C
C THE FOLLOWING DO-LOOP READS THE LINING SURFACE DIMENSION, Z DISPLACE-
C MENT, NORMAL VECTOR, AND MATERIAL ID FROM CARD TYPE 8. THEN MAX AND
C MIN VALUES OF ELMNT I AND J INDICES ARE COMPUTED FOR EACH SURF AND
C VRBL IRAY IS INITIALIZED.
C
      IJ = 0
      DO 103 I=1,LSN
      READ(5,8)SWD(I),Z(I),(VN(I,J),J=1,3),IMATL(I)
 8    FORMAT(5F10.1,I5)
      JMIN(I)=1
      JMAX(I)=15
      IX=IJ+1
      IJ=IJ+2.0*SWD(I)+TOL
```

```
      IMIN(I)=IX
      IMAX(I)=IJ
      II=I
      DO 102 JL=IX,IJ
 102  IRAY(JL)=II
C
      K = I + 1
      IF ( VN(I,1) .NE. 0. ) GO TO 1001
      SX(K) = SX(I) + VN(I,3) * SWD(I)
      SZ(K) = SZ(I)
      GO TO 103
C
 1001 SX(K) = SX(I)
      SZ(K) = SZ(I) - VN(I,1) * SWD(I)
C
 103  CONTINUE
C
      SX(LSN+1) = 0.
      SZ(LSN+1) = 0.
C
C TEST TO FIND IF MAX ALLOWABLE VALUE OF LINING SURF I INDEX IS EXCEEDED
C
      NERR=4
      IF(IMAX(LSN).GT.120)GO TO 100
      NERR=5
C
C TEST TO FIND IF MAX ALLOWABLE NUMBER OF ELMNTS (600) IS EXCEEDED.
C
      IF((IMAX(1)*JMAX(1)).GT.600)GO TO 100
      MAXELI=IMAX(LSN)
C
C DO-LOOP TO READ CARD(S) TYPE 9 : SEAT GROUP WIDTHS AND POSITIONS.
C THEN COMPUTE I AND J INDICES OF THE FLOOR ELMNTS OVER WHICH THE
C REFERENCE CORNER OF THE SEAT GROUP IS LOCATED. ALSO THE Z DISPLACE-
C MENT (HEIGHT ABOVE FLOOR) OF ALL SEATS IS 1.0 FT.
C
      DO 104 IS=1,NSG
      READ(5,9) SGWD(IS),XCOR(IS),YCOR(IS)
 9    FORMAT(8F10.1)
      IT=LSN+IS
      Z(IT)=1.0
      IONE(IS)=2.0*XCOR(IS)+TOL
      JONE(IS)=2.0*YCOR(IS)+TOL
 104  CONTINUE
C
C READ CARD TYPE 10: SEAT SURFACE MATERIAL ID NUMBERS. EACH SEAT SURFACE
C CAN BE A SEPARATE MATERIAL IF DESIRED.
C
      READ(5,10) (IMATS(I),I=1,7)
 10   FORMAT(20I2)
C
C READ CARD TYPE 11 - SEAT TO SIDEWALL FIRE SPREAD DATA. PARTITION
C  MATERIAL CODES
C
      READ(5,11) DWS, RFWS, (IMTLP(I), I=1,NCOMPS)
 11   FORMAT(2F10.1,4I5)
C
C READ CARD TYPE 12 - NUMBER OF VENTS ( MAX VALUE = 24 )
C
      READ(5,12) NV
 12   FORMAT(16I5)
```

```
      IF ( NV .EQ. 0 ) GO TO 106
C
C READ CARD(S) TYPE 13 - CONNECTED COMPARTMENTS, DIMENSIONS, FLOW RATES
C  FLOW DIRECTION
C
      DO 105 I=1,NV
      READ(5,13) I1, I2, VENTT(I), VENTH(I), VENTW(I), FLOW(I), INTO(I)
 13   FORMAT(2I5,4F10.1,I5)
      CNCTNS(I) = I1 * 10 + I2
 105  CONTINUE
C
 106  CONTINUE
C
C REMAINING STATEMENTS INITIALIZE THE ARRAY IRAYS
C
      IX=1
      DO 45 J=1,4
 45   IRAYS(J)=IX
      IX=IX+1
      DO 50 J=5,8
 50   IRAYS(J)=IX
      IX=IX+1
      DO 55 J=9,11
 55   IRAYS(J)=IX
      IRAYS(12)=4
      IX=IX+2
      DO 60 J=13,18
 60   IRAYS(J)=IX
      IX=IX+1
      DO 65 J=19,21
 65   IRAYS(J)=IX
      IRAYS(22)=7
C
 150  RETURN
      END
```

```
      SUBROUTINE RDMTLS
C
C --------------------------------------------------------------------
C OBJECTIVE(S)
C (1) READ IN ALL DATA DESCRIBING THE CABIN LINING SURFACES AND SEAT
C     MATERIALS.
C COMMENTS
C (1) TREATMENT OF UNUSED VARIABLES IN ARRAY OF GAS SPECIE NAMES MAY
C     BE MACHINE DEPENDENT.
C --------------------------------------------------------------------
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      DATA IBLNK/4H    /
C
C READ CARD TYPE 14 - NUMBER OF CABIN MATERIALS, NUMBER OF TRACE GASES
C
      READ(5, 14) NMATLS, NTXG
 14   FORMAT(16I5)
C
```

```
C TOTAL NUMBER OF GAS SPECIES ( INCLUDING SMOKE ) IS 6 + NTXG
C
      NSPCS = 6 + NTXG
      IF( NTXG .EQ. 0 ) GO TO  1001
C
C READ CARD TYPE 15 - TRACE GAS IDENTIFICATION DATA
C
      DO 100 IG=1,NTXG
      READ(5,15) NGS,FMW
 15   FORMAT( A4, 6X, F10.0 )
      NGAS(5 +IG) = NGS
      WMOLEC(5 + IG) = FMW
 100  CONTINUE
C
C FIRST FIVE SPECIES ARE ASSUMED TO BE N2, O2, 'FUEL', CO2, AND H2O
C
 1001 NGAS(1) = 'N2'
      WMOLEC(1) = 28.
      NGAS(2) = 'O2'
      WMOLEC(2) = 32.
      NGAS(3) = 'FUEL'
      WMOLEC(3) = 999.
      NGAS(4) = 'CO2'
      WMOLEC(4) = 44.
      NGAS(5) = 'H2O'
      WMOLEC(5) = 18.
      NGAS(NSPCS) = 'SMOK'
      WMOLEC(NSPCS) = 999.
C
C READ CARD TYPE 16 - HEAT OF COMBUSTION, STOICHIOMETRIC RATIO,
C  FUEL VAPOR CHARACTERISTICS, AND RADIATED FRACTION
C
      DO 101 M=1,NMATLS
 101  READ(5,16) QTAB(M), GTAB(M), WMMTL(M), RTAB(M), UTAB(M), RADTAB(M)
 16   FORMAT(8F10.1)
C
C READ CARD TYPE 17 - SMLDRG THRESHOLD FLUX LEVELS
C
      READ(5,17) (QP(M), M=1,NMATLS)
 17   FORMAT(8F10.1)
C
C READ CARD TYPE 18, TRANSITION TIME(S) TO SMOLDERING FOR EACH MATERIAL
C
      READ(5,18) (TP(M),M=1,NMATLS)
 18   FORMAT(8F10.1)
C
C READ CARD TYPE 19, TRANSITION TIME(S) SMLDRG-TO-CHARRED FOR EACH MATL
C
      READ(5,19) (TPC(M),M=1,NMATLS)
 19   FORMAT(8F10.1)
C
C READ CARD TYPE 20, SMOKE PRODUCTION RATE(S) FOR SMLDRG MATERIAL(S)
C
      READ(5,20) (RSS(M),M=1,NMATLS)
 20   FORMAT(8F10.1)
      DO 103 IG=1,NTXG
C
C READ CARD(S) TYPE 21, GAS PRDCTN RATES IN SMLDRG STATE FOR EACH MATL
C
      READ(5,21) (RGS(IG,M),M=1,NMATLS)
 21   FORMAT(8F10.1)
```

```
C
C CONVERT GAS PRDCTN RATES FROM MICROLBM/(FT*FT*SEC) TO LBM/(FT*FT*SEC)
C
      DO 102 M=1,NMATLS
      RGS(IG,M)=RGS(IG,M)*1.E-6
  102 CONTINUE
  103 CONTINUE
C
C THE NEXT FOUR STMTS READ THE TABLES OF FLAMING STATE PROPERTIES.
C EACH TABLE CONSISTS OF SIX PAIRS OF (RADIATION LEVEL, PROPERTY VALUE)
C AND OCCUPIES ONE RECORD (CARD). RADIATION LEVELS SHOULD BE IN
C ASCENDING ORDER. TABLES FOR A GIVEN PROPERTY ARE READ FOR ALL MATLS
C BEFORE GOING ON TO THE NEXT PROPERTY. THESE ARE CARD TYPES 22 THRU 34
C
      IEND=NTXG+8
      DO 104 NO=1,IEND
      READ(5,22) ((TABX(NO,M,N),TABY(NO,M,N),N=1,6),M=1,NMATLS)
   22 FORMAT(6(F5.1,F8.1))
  104 CONTINUE
C
C CONVERT ALL GAS PRDCTN RATES FROM MICROLBM/(FT*FT*S) TO LBM/(FT*FT*S)
C
      DO 117 NO=9,IEND
      DO 117 M=1,NMATLS
      DO 116 N=1,6
  116 TABY(NO,M,N)=TABY(NO,M,N)*1.E-6
  117 CONTINUE
C
C READ CARD TYPE 35 - BULK THERMAL PROPERTIES OF MATERIALS, INSULATION
C
      DO 150 M=1,NMATLS
  150 READ(5,40) CPM(M), RHOM(M), TKNS(M), CNDCTY(M), TKNSIN(M)
   40 FORMAT(5F10.1)
C
C READ CARD TYPE 36 - AMBIENT TEMPERATURE AND PRESSURE
C
      READ(5,41) TAM, PAMB
   41 FORMAT(8F10.1)
C
C THE NEXT 8 STMTS INITIALIZE THE INTEGER ARRAYS CONTAINING TIMES TO
C START SMLDRG AND TIME TO SMLDR OUT. ARRAYS ARE SUBSCRIPTED BY SURFACE
C NUMBER.
C
  200 DO 210 I=1,LSN
      M=IMATL(I)
      ITP(I)=TP(M)+0.5
  210 ITPC(I)=TPC(M)+0.5
      DO 220 IS=1,7
      M=IMATS(IS)
      ITPS(IS)=TP(M)+0.5
  220 ITPCS(IS)=TPC(M)+0.5
      RETURN
      END
```

```
      SUBROUTINE INITLZ
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) INITIALIZE MOST CONSTANTS AND VARIABLES
C (2) SET ALL ELEMENT STATES TO THE INITIAL (VIRGIN) STATE
C (3) COMPUTE FLAME SPREAD CALCULATION INTERVALS, DELTSP AND ITSPRD
C COMMENTS
C (1) SEE MAIN PGM FOR BEST DEFINITION OF VARIABLES
C (2) SOME ELMNT STATES MAY BE RE-INITIALIZED BY SUBR RDIGTN WHICH
C     FOLLOWS DOWNSTREAM
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      DIMENSION X(120)
C INITIALIZE VARIOUS CONSTANTS.
      PI=3.1415927
      GRAV = 32.174
      RGAS = 1545.0
      CP=0.24
      SIGMA=4.761E-13
```

```
      THOU=1000.0
      QTR=0.25
C ABSORPTION COEFFICIENT FOR ALL FIRES IS GIVEN THE DEFAULT VALUE 0.25.
      DO 191 K=1,30
 191  ABSCF(K)=0.25
C INITIALIZE MORE CONSTANTS.
      EB=16.3
      EC=0.11
      EP=0.10
C COMPUTE THE OXYGEN CONSUMPTION FACTOR FOR EACH MATERIAL.
      DO 190 M=1,NMATLS
 190  FOX(M)=QTAB(M)/GTAB(M)
C INITIALIZE THE HEAT FLUX VARIABLES QC(1) AND QC(2).
      QC(1)=0.
      QC(2)=0.
C THE NEXT 12 STMTS INITIALIZE THE IWORD AND ISTATE ARRAYS FOR ALL CABIN
C LINING SURFACE ELEMENTS.
      I=0
 10   I=I+1
      I1=IMIN(I)
      I2=IMAX(I)
      DO 20 II=I1,I2
      J1=JMIN(I)
      J2=JMAX(I)
      DO 15 JJ=J1,J2
      IWORD(II,JJ)=0
 15   ISTATE(II,JJ)=11
 20   CONTINUE
C TEST IF ALL LINING SURFACES HAVE BEEN COVERED.
      IF(I.LT.LSN) GO TO 10
C THE NEXT 14 STMTS INITIALIZE THE IWORDS AND ISTATS ARRAYS FOR ALL SEAT
C ELEMENTS.
      I=LSN
 30   I=I+1
      IS=I-LSN
      JMIN(I)=1
      JMAX(I)=22
      IMIN(I)=1
      IMAX(I)=2.0*SGWD(IS)+TOL
      I2=IMAX(I)
      DO 40 JJ=1,22
      DO 35 II=1,I2
      IWORDS(IS,II,JJ)=0
 35   ISTATS(IS,II,JJ)=11
 40   CONTINUE
      IF(I.LT.NS) GO TO 30
C TEST IF ALL SEAT GROUPS HAVE BEEN COVERED.
C INITIALIZE THE ARRAY 'IF' USED TO ORGANIZE FIRE BASE AREAS.
      DO 60 IJ=1,600
 60   IF(IJ)=0
C SET THE COUNTERS OF SMLDRG, FLAMING, AND CHARRED ELMNTS PER SURF TO 0.
      DO 70 I=1,NS
      NCE(I)=0
      NPE(I)=0
 70   NFE(I)=0
C
C CALL SUBR INIT2 TO SET UP GEOMETRY ARRAYS
C
      CALL INIT2
C
C CONVERT THE SMALL TIME STEP SIZE AND STOP TIME FROM THE (INPUT) VALUE
```

```
C IN SECONDS TO MILLISECONDS
      IDELT=DELTAT*THOU+0.1
      IDTPRV=IDELT
      ITFIN=TFINAL*THOU+0.1
C A VALUE OF IRATIO = 0 RESULTS IN A FLAME SPREAD CALCULATION AT EACH
C SMALL INTEGRATION STEP (EACH IDELT). THIS IS A DEFAULT SETTING
      IF(IRATIO.GT.0)GO TO 80
      ITSPRD=1
      DELTSP=1.0
      GO TO 90
C ITSPRD IS THE TIME BETWEEN FLAME SPREAD PASSES IN MILLISECONDS, AND
C DELTSP IS THE SAME QUANTITY GIVEN IN SECONDS. ONCE THESE VALUES ARE
C INITIALIZED THEY REMAIN CONSTANT IN THIS VERSION (3.0)
 80   ITSPRD=IDELT*IRATIO
      DELTSP=ITSPRD/THOU
 90   CONTINUE
C IPEMS IS THE INTERVAL IN MILLISECONDS BETWEEN SUCCESSIVE OUTPUT OF THE
C CABIN GAS VARIABLES. IPSPR IS THE CORRESPONDING VALUE FOR THE FLAME
C SPREAD CALCULATIONS.
      IPEMS=IPEMS*THOU+0.1
      IPSPR=IPSPR*THOU+0.1
      IPAUX = IPAUX * THOU + 0.1
C
      DO 110 NC=1,NCOMPS
C
C INITIALIZE SPECIES MASS FRACTIONS AND SMOKE FOR UPPER AND LOWER ZONES
C  OF ALL COMPARTMENTS
C
      CHIL(1,NC) = 0.77
      CHIU(1,NC) = 0.77
      CHIL(2,NC) = 0.23
      CHIU(2,NC) = 0.23
      CHIL(3,NC) = 0.0
      CHIU(3,NC) = 0.0
      CHIL(4,NC) = 0.0
      CHIU(4,NC) = 0.0
      CHIL(5,NC) = 0.0
      CHIU(5,NC) = 0.0
C
      DO 100 NT=1,NTXG+1
      CHIL(5+NT,NC) = 0.0
      CHIU(5+NT,NC) = 0.0
 100  CONTINUE
 110  CONTINUE
C
C COMPARTMENT NUMBER 5 IS THE EXTERIOR ALWAYS
C
      CHIL(1,5) = 0.77
      CHIU(1,5) = 0.77
      CHIL(2,5) = 0.23
      CHIU(2,5) = 0.23
      CHIL(3,5) = 0.0
      CHIU(3,5) = 0.0
      CHIL(4,5) = 0.0
      CHIU(4,5) = 0.0
      CHIL(5,5) = 0.0
      CHIU(5,5) = 0.0
C
C ALL COMPARTMENT PRESSURES, TEMPERATURES, AND DENSITIES ARE SET TO
C  THE AMBIENT VALUES
C
```

```
      DO 115 NC=1,NCOMPS
      PF(NC) = PAMB
      TL(NC) = TAM
      TU(NC) = TAM
      RHOL(NC) = PAMB / ( 53.42324 * TAM )
      RHOU(NC) = RHOL(NC)
C CONVERT PRESSURE UNITS TO LBM/(FT-SEC**2)
      PF(NC) = PF(NC) * GRAV
C
C TO AVOID STARTING PROBLEMS THE UPPER ZONE VOLUME IS INITIALIZED
C  TO A NON-ZERO VALUE OF 0.001 * COMPARTMENT VOLUME
C
      CALL XSEC( CH, AREA )
      VTOTAL(NC) = CL(NC) * AREA
      VOLL(NC) = 0.999 * VTOTAL(NC)
      VOLU(NC) = 0.001 * VTOTAL(NC)
C
C SET THE THERMAL DISCONTINUITY POSITION (LOWER ZONE THICKNESS) FROM
C  THE LOWER ZONE VOLUME
C
      ZDG = 0.999 * CH
      CALL HEIGHT( NC, VOLL(NC), ZDG, ZD(NC) )
C
C
 115  CONTINUE
C
      DO 120 NC=6,11
      CHIL(NC,5) = 0.0
      CHIU(NC,5) = 0.0
 120  CONTINUE
C
      PF(5) = PAMB
      TU(5) = TAM
      TL(5) = TAM
C
      RHOU(5) = PAMB / ( 53.42324 * TAM )
      RHOL(5) = RHOU(5)
      PF(5) = PF(5) * GRAV
      VOLL(5) = 99999.
      VOLU(5) = 99999.
C
      ZD(5) = 99999.
C
C SET THE MATERIALS SURFACE TEMPERATURES TO THE AMBIENT
C
      DO 130 IC=1,NCOMPS
      TSP(1,1,IC) = TAM
      TSP(1,2,IC) = TAM
      TSP(2,1,IC) = TAM
      TSP(2,2,IC) = TAM
      DO 130 J=1,LSN
      TSL(J,1,IC) = TAM
      TSL(J,2,IC) = TAM
 130  CONTINUE
C
C INITIALIZE ARRAY TWO
C
      DO 140 IC=1,50
      TWO(IC+51) = 2. ** IC
      TWO(51-IC) = 2. ** (-IC)
 140  CONTINUE
```

```
      TWO(51) = 1.
C
C INITIALIZE ARRAY X
C
      I = 0
      DO 170 N2=1,NCOMPS
      DO 150 N1=1,NSPCS
      I = I + 1
 150  X(I) = CHIL(N1,N2)
      DO 160 N1=1,NSPCS
      I = I + 1
 160  X(I) = CHIU(N1,N2)
      X(I+1) = PF(N2)
      X(I+2) = RHOL(N2)
      X(I+3) = RHOU(N2)
      X(I+4) = TL(N2)
      X(I+5) = TU(N2)
      X(I+6) = VOLL(N2)
      X(I+7) = VOLU(N2)
      X(I+8) = ZD(N2)
      I = I + 8
 170  CONTINUE
C
C TO INITIALIZE ARRAY JCOR CALL SCALE WITH ISW = 0
C
      CALL SCALE(0,X,I)
C
C INITIALIZE ARRAY XTHEN
C
      DO 180 JJ=1,I
      XTHEN(JJ) = X(JJ)
 180  CONTINUE
C
C
C SET THE IGNITION SOURCE FLAG TO A DEFAULT OF ZERO
C
      IBURN = 0
      RETURN
      END
```

```
      SUBROUTINE INIT2
C ----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) THIS SUBROUTINE INITIALIZES 10 ARRAYS CONTAINING INFORMATION ABOUT
C     THE GEOMETRIC RELATIONSHIP AMONG THE CABIN SURFACES:
C
C      IARX(L,N) INDICATES POSITION OF SEAT GROUPS WITH RESPECT TO THE
C                FLOOR (X-Y) PLANE. SUBSCRIPTS CORRESPOND TO THE I AND J
C                INDICES OF THE FLOOR ELEMENTS. VALUE IS THE NUMBER OF
C                THE SEAT GROUP DIRECTLY ABOVE FLOOR ELMNT L,N. VALUE
C                OF ZERO INDICATES NO SEAT GROUP ABOVE.
C
C      IARY(L,N) INDICATES POSITION OF OVERHEAD SURFACES (CEILING, HAT
C                RACK, PSU'S, ETC.) WITH RESPECT TO SEAT GROUPS AND
C                FLOOR. SUBSCRIPT L EQUALS THE FLOOR I INDEX. SUBSCRIPT
C                N IS USED AS FOLLOWS:
C                 N=1,NON-ZERO VALUE = J INDEX OF ELMNTS ON SEAT GROUP 1
C                     WHICH ARE IN THE SAME Y-Z PLANE AS FLOOR ELMNTS
C                     WITH I INDEX = L.
C                 N=2,NON-ZERO VALUE = J INDEX OF ELMNTS ON SEAT GROUP 2
C                     WHICH ARE IN THE SAME Y-Z PLANE AS FLOOR ELMNTS
C                     WITH I INDEX = L.
C
C                 ... AND SO ON THRU
C
C                 N=9,NON-ZERO VALUE = J INDEX OF ELMNTS ON SEAT GROUP 9
C                     WHICH ARE IN THE SAME Y-Z PLANE AS FLOOR ELMNTS
C                     WITH I INDEX = L.
C                 A ZERO VALUE FOR IARY(L,N=1 THRU 9) INDICATES NO SEAT
C                 GROUP N ELMNTS ARE IN THE SAME Y-Z PLANE AS FLOOR
C                 ELMNT (L,N)
C                FOR N=10 AND 11 IARY CONTAINS DATA ON THE HAT RACK IF
C                IT EXISTS. ONLY ONE HAT RACK (FOR EACH SIDE OF THE
C                CABIN) IS ALLOWED. IF THERE IS NO HAT RACK IARY(L,10)
C                AND IARY(L,11) WILL REMAIN ZERO.
C                 N=10, VALUE = I INDEX OF ELMNTS ON HAT RACK BOTTOM
C                       SURF (FACING FLOOR) WHICH ARE IN THE SAME Y-Z
C                       PLANE AS FLOOR ELMNTS WITH I INDEX = L.
C                 N=11, VALUE = I INDEX OF ELMNTS ON HAT RACK UPPER
C                       SURF (FACING CEILING) WHICH ARE IN THE SAME Y-Z
C                       PLANE AS FLOOR ELMNTS WITH I INDEX = L.
C                FOR N=12 IARY CONTAINS DATA ON CEILING SURFACES WHICH
C                ARE PARALLEL TO AND FACING THE FLOOR.
C                 N=12, VALUE = I INDEX OF ELMNTS ON CEILING (OR PSU,
C                       STOW BIN, ETC) SURFS WHICH ARE IN THE SAME Y-Z
C                       PLANE AS FLOOR ELMNTS WITH I INDEX = L.
C
C      ISWSL(L,N) INDICATES THE POSITION OF THE LEFT-MOST SEAT GROUPS
C                 WITH RESPECT TO THE LEFT CABIN SIDEWALL. ( LEFT IS
C                 DEFINED BY A VIEW FACING AFT. ) SUBSCRIPT L EQUALS THE
C                 SIDEWALL J INDEX AND N IS USED AS FOLLOWS:
C                 N=1, VALUE = SEAT GROUP NUMBER ADJACENT TO SIDEWALL
C                      ELMNTS WITH J INDEX = L.
C                 N=2,3,4,....,8  VALUE = J INDEX OF SEAT ELMNT NEAREST
C                      TO SIDEWALL ELMNT WITH J INDEX = L. FOR N=2 THESE
C                      ARE SEAT ELMNTS ON THE CUSHION TOP AND LOWEST
C                      REAR ROW OF THE BACK REST, FOR N=3 NEAREST ELMNTS
C                      ARE ON THE NEXT HIGHEST REAR BACKREST ROW, ETC.
C                 EXAMPLE: ARRAY ISWSL FOR 2 SEATS (NUMBERS 1 AND 4)
C                      ADJACENT TO THE LEFT SIDEWALL STARTING AT J=2
C                      AND J=8 ON THE SIDEWALL:
```

```
C                    N
C           ISWSL(L,8) =              11                    11
C           ISWSL(L,7) =              10                    10
C           ISWSL(L,6) =               9                     9
C           ISWSL(L,5) =               8                     8
C           ISWSL(L,4) =               7                     7
C           ISWSL(L,3) =               6                     6
C           ISWSL(L,2) =      21 20 19 5          21 20 19 5
C           ISWSL(L,1) =       1  1  1 1           4  4  4 4
C                      L= 1  2  3  4 5  6  7  8  9 10 11 12 ... 15
C           VALUES OF THE ARRAY FOR ALL OTHER L,N PAIRS WILL BE ZERO.
C
C      ISWSR(L,N) INDICATES THE POSITION OF THE RIGHT-MOST SEAT GROUPS
C                 WITH RESPECT TO THE RIGHT CABIN SIDEWALL. VALUES AND
C                 SUBSCRIPT DEFINITIONS DEFINED ANALOGOUSLY TO ISWSL.
C
C      ISSWLI(IS,N)
C         AND        THESE ARRAYS INDICATE THE POSITION OF THE LEFT
C      ISSWLJ(IS,N) SIDEWALL WITH RESPECT TO THE LEFT-MOST SEAT GROUPS.
C                    THEY CONTAIN VALUES OF SIDEWALL ELMNT I AND J
C                    INDICES NEAREST TO THE SEAT ELMNTS WITH I INDICES
C                    GIVEN BY N.  IS IS THE SEAT GROUP NUMBER.
C
C      ISSWRI(IS,N)
C         AND        THESE ARRAYS INDICATE THE POSITION OF THE RIGHT
C      ISSWRJ(IS,N) SIDEWALL WITH RESPECT TO THE RIGHT-MOST SEAT GROUPS.
C                    THEY CONTAIN VALUES OF SIDEWALL ELMNT I AND J
C                    INDICES NEAREST TO THE SEAT ELMNTS WITH I INDICES
C                    GIVEN BY N.  IS IS THE SEAT GROUP NUMBER.
C
C      XMX(I) AND XMN(I) ARE THE MAXIMUM AND MINIMUM DISTANCES (FT)
C                    OF LINING SURFACE I ABOVE THE FLOOR
C
C (2) THIS SUBROUTINE ALSO DETERMINES THE VALUES OF THE FOLLOWING:
C
C      FHMIN = THE MINIMUM DISTANCE FROM THE CABIN FLOOR TO THE
C              CEILING IN FT.
C      NPROJ = A FLAG TO INDICATE THE PRESENCE OF PROJECTING SURFACES
C              (HAT RACKS), NPROJ = 1 => HAT RACK IS PRESENT.
C      IPJUL = SURFACE NUMBER OF THE UPPER LEFT HAT RACK SURFACE
C      IPJLL = SURFACE NUMBER OF THE LOWER LEFT HAT RACK SURFACE
C      IPJUR = SURFACE NUMBER OF THE UPPER RIGHT HAT RACK SURFACE
C      IPJLR = SURFACE NUMBER OF THE LOWER RIGHT HAT RACK SURFACE
C      IFIRL = I INDEX OF HIGHEST ELMNT ON LEFT SIDEWALL NEXT TO A SEAT
C      IFIRR = I INDEX OF LOWEST ELMNT ON RIGHT SIDEWALL NEXT TO A SEAT
C      ILSTL = I INDEX OF LOWEST ELMNT ON LEFT SIDEWALL NEXT TO A SEAT
C      ILSTR = I INDEX OF HIGHEST ELMNT ON RIGHT SIDEWALL NEXT TO A SEAT
C
C COMMENTS
C (1) THE PURPOSE OF MOST OF THIS INFORMATION IS THE CALCULATION OF
C     FLAME SPREAD IN SUBROUTINES COND, CONDS, FCON, AND FCONS, AND THE
C     PROPAGATION OF SMOLDERING REGIONS IN PVOL AND PVOLS.
C (2) BEFORE STUDYING THE OPERATION OF THIS SUBROUTINE REVIEW OF THE
C     ELEMENT NUMBERING CONVENTIONS GIVEN IN THE USER'S GUIDE, APDX C OF
C     [2] IS RECOMMENDED.
C -----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
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```
     1              IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2              RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3              TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4              ACM(7),AF(30),AFI,AEXP,COMB(30),DQK,FLML(30),FSN1,
     5              FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6              IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7              IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8              JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9              NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1              RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDQ,
     2              TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3              FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDQMTL(7),
     4              TP(7),TPC(7)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1              RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2              VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3              JCOR(120)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1              IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2              CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3              ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4              ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10)
     5              ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6              IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7              SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8              XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9              HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1              CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2              FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1              FOX(7),NMATLS,DQI,DQM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2              ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3              ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4              RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5              XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6              WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
C INITIALIZE IARY AND IPJLL THRU IPJUR TO ZERO.  I2 IS THE HIGHEST I
C INDEX VALUE ON THE FLOOR
      I2=IMAX(1)
      DO 2 N=1,12
      DO 2 L=1,I2
 2    IARY(L,N)=0
      IPJLL=0
      IPJUL=0
      IPJLR=0
      IPJUR=0
C THE LOOP THRU STMT 5 LOADS IARY(L,12) WITH I INDICES FROM THE CEILING
C ICLR IS THE RIGHT-MOST CEILING SURF, ICLL THE LEFT-MOST.
      L=I2+1
      DO 5 I=ICLR,ICLL
C SKIP VERTICAL CEILING SURFACES
      IF(VN(I,3).EQ.0.)GO TO 5
      I1=IMIN(I)
      I2=IMAX(I)
      DO 4 II=I1,I2
      L=L-1
 4    IARY(L,12)=II
 5    CONTINUE
C INITIALIZE NPROJ AND PREPARE TO LOAD IARY(L,11)
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```
      NPROJ=0
      IDX=11
      IX=ICLL+1
C LOOP THRU STMT 9 LOADS IARY(LL,11) WITH UPPER HAT RACK SURFACE I
C INDICES. IF NO SUCH UPWARD FACING SURFACES ARE FOUND NO LOADING TAKES
C PLACE AND NPROJ WILL STAY = 0.
      DO 9 I=IX,LSN
C TEST FOR SURFACE I BEING UPWARD FACING BY USING Z-COMPONENT OF NORMAL
      IF(VN(I,3).NE.1.0)GO TO 9
      IPJUL=I
      LL=0
      I1=IMIN(I)
      I2=IMAX(I)
      DO 7 II=I1,I2
      LL=LL+1
 7    IARY(LL,IDX)=II
C HAT RACK FOUND, NPROJ=1:
      NPROJ=1
      ISTOR=I
C SINCE A HAT RACK WAS FOUND SKIP TO STMT 11 TO FINISH FILLING
C IARY(LL,11)
      GO TO 11
 9    CONTINUE
C IF CONTROL REACHES THIS POINT,NO HAT RACK EXISTS SO SKIP TO STMT 27
      GO TO 27
C LOOP THRU STMT 14 LOADS IARY(LL,10) WITH I INDICES FROM THE LOWER
C SURFACE OF THE HAT-RACK.
 11   IX=ISTOR+1
      IDX=10
      DO 14 I=IX,LSN
      IF(VN(I,3).NE.-1.0)GO TO 14
      IPJLL=I
      I1=IMIN(I)
      I2=IMAX(I)
      LL=I2-I1+2
      DO 13 II=I1,I2
      LL=LL-1
 13   IARY(LL,IDX)=II
      GO TO 17
 14   CONTINUE
C IF CONTROL REACHES THIS POINT NO HAT RACK LOWER SURFACE HAS BEEN FOUND
C TO MATCH THE UPPER LEFT SURFACE DISCOVERED PREVIOUSLY.  THEREFORE
C WRITE AN ERROR MESSAGE AND STOP.
      WRITE(6,15)
 15   FORMAT(/10X,48HHAT RACK LEFT LOWER SURFACE.NOT FOUND.-.PGM.STOP)
 999  STOP
C LOOP THRU STMT 20 LOADS IARY(LL,10) FOR THE LOWER SURFACE OF THE RIGHT
C HAT RACK.
 17   IX=ICLR-1
      DO 20 I=2,IX
      IF(VN(I,3).NE.-1.0)GO TO 20
      IPJLR=I
      I1=IMIN(I)
      I2=IMAX(I)
      IDX=10
      LL=IMAX(1)+1
      DO 19 II=I1,I2
      LL=LL-1
 19   IARY(LL,IDX)=II
      ISTOR=I
      GO TO 22
```

```
20    CONTINUE
C IF NO RIGHT HAT RACK LOWER SURFACE IS FOUND (AFTER A LEFT HAT RACK
C HAS BEEN), WRITE AN ERROR MESSAGE AND STOP
      WRITE(6,21)
 21   FORMAT(/10X,49HHAT RACK RIGHT LOWER SURFACE NOT FOUND - PGM STOP)
      GO TO 999
22    IT=ISTOR+1
      IDX=11
C LOOP THRU STMT 24 LOADS IARY(LL,11) FOR THE UPPER SURFACE OF THE RIGHT
C HAT RACK.
      DO 24 I=IT,IX
      IF(VN(I,3).NE.1.0)GO TO 24
      IPJUR=I
      I1=IMIN(I)
      I2=IMAX(I)
      LL=IMAX(1)-I2+I1-1
      DO 23 II=I1,I2
      LL=LL+1
23    IARY(LL,IDX)=II
      GO TO 27
24    CONTINUE
C IF NO RIGHT HAT RACK UPPER SURFACE IS FOUND WRITE A MESSAGE AND STOP.
      WRITE(6,25)
 25   FORMAT(/10X,49HHAT RACK RIGHT UPPER SURFACE NOT FOUND - PGM STOP)
      GO TO 999
C THE NEXT 15 STMTS INITIALIZE ARRAY IARX. FIRST LOAD THE ARRAY WITH 0.
27    I2=IMAX(1)
      DO 30 N=1,15
      DO 30 L=1,I2
30    IARX(L,N)=0
C LOOP THRU STMT 40 LOADS THE SEAT GROUP NUMBER INTO IARX(L,N) WHERE
C L AND N HAVE VALUES EQUAL TO THE FLOOR I AND J INDICES OVER WHICH A
C SEAT GROUP STANDS. IONE AND JONE HAVE BEEN COMPUTED FROM XCOR AND YCOR
C IN SUBROUTINE INPUTG.
      DO 40 IS=1,NSG
      I1=IONE(IS)+1
      I2=SGWD(IS)*2.0+TOL
      I2=IONE(IS)+I2
      J1=JONE(IS)+1
      J2=JONE(IS)+4
      IX=IS
      DO 35 L=I1,I2
      DO 35 N=J1,J2
35    IARX(L,N)=IX
40    CONTINUE
C THE NEXT 49 STMTS LOAD THE ARRAYS ISWSR AND ISWSL. FIRST SET THEM TO
C ZERO.
      I2=JMAX(1)
      DO 45 L=1,I2
      DO 45 N=1,8
      ISWSR(L,N)=0
45    ISWSL(L,N)=0
C ILSTL, IFIRL, IFIRR, AND ILSTR ARE FOUND FROM THE MAXIMUM LINING SURF
C I VALUE, IMAX(LSN), AND THE MINIMUM I INDEX FOR THE FIRST RIGHT SIDE-
C WALL SURFACE, IMIN(2). NOTE HOW THE ASSUMPTION OF STANDARD SEAT SIZE
C AND POSITION IS USED.
      ILSTL=IMAX(LSN)-2
      IFIRL=ILSTL-6
      IFIRR=IMIN(2)+2
      ILSTR=IFIRR+6
C LOOP THRU STMT 60 SETS UP ISWSR(L,N)
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      DO 60 IS=1,NSG
      IX=IS
      I=LSN+IS
C IEND IS THE VALUE OF THE FLOOR I INDEX BELOW THE RIGHT EDGE OF A SEAT
C GROUP.  IF THE DISTANCE BETWEEN THE SEAT RIGHT EDGE AND THE RIGHT SIDE-
C WALL IS > 2 ELMNTS DO NOT INCLUDE THIS SEAT IN ISWSR
      IEND=2.0*SGWD(IS)+TOL
      IEND=IONE(IS)+IEND
      IF((IMAX(1)-IEND).GT.2)GO TO 60
      J1=JONE(IS)+1
      J2=JONE(IS)+3
      JJ=22
C LOOP THRU STMT 50 SETS UP ISWSR(L,1) AND ISWSR(L,2) FOR SEAT CUSHION
C ELMNTS.  SUBSCR L DETERMINED BY POSITION OF SEAT WRT SIDEWALL J INDEX.
      DO 50 J=J1,J2
      JJ=JJ-1
      ISWSR(J,1)=IX
      ISWSR(J,2)=JJ
 50   CONTINUE
      L=J2+1
      ISWSR(L,1)=IX
      JJ=4
C LOOP THRU STMT 55 SETS UP ISWSR(L,2) THRU (L,8) FOR SEAT BACK ELMNTS
C SUBSCR L DETERMINED BY POSITION OF SEAT WRT SIDEWALL,J INDEX.
      DO 55 N=2,8
      JJ=JJ+1
 55   ISWSR(L,N)=JJ
 60   CONTINUE
C LOOP THRU STMT 75 SETS UP ISWSL(L,N)
      DO 75 IS=1,NSG
      IX=IS
      I=LSN+IS
C IF THE LEFT EDGE OF THE SEAT GROUP IS GREATER THAN 2 ELMNTS FROM THE
C LEFT SIDEWALL, DO NOT INCLUDE THIS SEAT IN ISWSL.
      IF(IONE(IS).GT.2)GO TO 75
      J1=JONE(IS)+1
      J2=JONE(IS)+3
      JJ=22
C LOOP THRU STMT 65 SETS UP ISWSL(L,1) AND (L,2) FOR SEAT CUSHION ELMNTS
C SUBSCR L DETERMINED BY POSITION OF SEAT WRT SIDEWALL J INDEX.
      DO 65 J=J1,J2
      JJ=JJ-1
      ISWSL(J,1)=IX
      ISWSL(J,2)=JJ
 65   CONTINUE
      L=J2+1
      ISWSL(L,1)=IX
      JJ=4
C LOOP THRU STMT 70 SETS UP ISWSL(L,2) THRU (L,8) FOR SEAT BACK ELMNTS
C SUBSCR L DETERMINED BY POSITION OF SEAT WRT SIDEWALL J INDEX.
      DO 70 N=2,8
      JJ=JJ+1
 70   ISWSL(L,N)=JJ
 75   CONTINUE
C THE NEXT 35 STMTS (THRU STMT 115) SET UP THE 4 ARRAYS ISSWLI, ISSWLJ,
C ISSWRI, AND ISSWRJ. FIRST LOAD THEM WITH ZERO.
      DO 85 IS=1,9
      DO 80 J=1,10
      ISSWRI(IS,J)=0
      ISSWRJ(IS,J)=0
      ISSWLI(IS,J)=0
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 80    ISSWLJ(IS,J)=0
 85    CONTINUE
C LOOP OVER THE NUMBER OF SEAT GROUPS, NSG. IEND IS AGAIN THE MAXIMUM
C RIGHT FLOOR I INDEX OVER WHICH SEAT GROUP IS STANDS. THE SEAT MUST BE
C WITHIN 2 ELMNTS OF THE RT SIDEWALL TO BE INCLUDED IN ISSWRI AND ISSWRJ
       DO 115 IS=1,NSG
       IEND=2.0*SGWD(IS)+TOL
       IEND=IONE(IS)+IEND
       IF((IMAX(1)-IEND).GT.2)GO TO 100
       IX=JONE(IS)
C LOAD THE J=1 TO J=4 MEMBERS OF ISSWRI AND ISSWRJ WITH VALUES OF RIGHT
C SIDEWALL INDICES.
       DO 90 J=1,4
       IX=IX+1
       ISSWRI(IS,J)=IFIRR
 90    ISSWRJ(IS,J)=IX
C LOAD THE J=5 TO J=10 MEMBERS OF ISSWRI AND ISSWRJ WITH VALUES OF RIGHT
C SIDEWALL INDICES.
       IX=JONE(IS)+4
       IY=ILSTR+1
       DO 95 J=5,10
       IY=IY-1
       ISSWRI(IS,J)=IY
 95    ISSWRJ(IS,J)=IX
C LOAD THE J=1 TO J=4 MEMBERS OF ISSWLI AND ISSWLJ WITH VALUES OF LEFT
C SIDEWALL INDICES.
 100   IF(IONE(IS).GT.2)GO TO 115
       IX=JONE(IS)
       DO 105 J=1,4
       IX=IX+1
       ISSWLI(IS,J)=ILSTL
 105   ISSWLJ(IS,J)=IX
       IX=JONE(IS)+4
       IY=IFIRL-1
C LOAD THE J=5 TO J=10 MEMBERS OF ISSWLI AND ISSWLJ WITH VALUES OF LEFT
C SIDEWALL INDICES.
       DO 110 J=5,10
       IY=IY+1
       ISSWLI(IS,J)=IY
 110   ISSWLJ(IS,J)=IX
 115   CONTINUE
C THE NEXT 8 STMTS COMPUTE THE MINIMUM DISTANCE FROM THE CABIN FLOOR TO
C THE CEILING, FHMIN, FT. IF A HAT RACK IS PRESENT FHMIN = FLOOR TO HAT
C RACK DISTANCE.
       IF(NPROJ.EQ.0)GO TO 117
       FHMIN=Z(IPJLL)
       GO TO 120
 117   FHMIN=Z(ICLL)
       I2=ICLL-1
       DO 119 I=ICLR,I2
       IF(Z(I).GT.0. .AND. Z(I).LT.FHMIN)FHMIN=Z(I)
 119   CONTINUE
C THE NEXT 19 STMTS COMPUTE THE MINIMUM DISTANCE, XMN, AND MAXIMUM
C DISTANCE, XMX, OF A LINING SURFACE FROM THE FLOOR. HORIZONTAL SURFACES
C (THOSE PARALLEL TO THE FLOOR) WILL HAVE XMN=XMX AND THE FLOOR (SURF 1)
C WILL HAVE XMN = XMX = 0. NOTE THAT BETTER VARIABLE NAMES WOULD BE
C ZMX AND ZMN. VALUES ARE IN FT.
 120   XMN(1)=0
       XMX(1)=0.
       DO 129 I=2,LSN
C WHEN THE Z-COMPONENT OF THE SURF NORMAL, VN(I,3), IS ZERO SURF I IS
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C VERTICAL  SO XMN IS NOT = XMX
      IF(VN(I,3) .EQ. 0.) GO TO 121
C HORIZONTAL SURFACE, XMX = XMN = Z, THE SURFACE DISPLACEMENT.
      XMN(I)=Z(I)
      XMX(I)=Z(I)
      GO TO 129
C TEST TO FIND IF THIS IS A RIGHT FACING VERT. SURF, VN(I,1) > 0.
 121  IF(VN(I,1).GT.0.) GO TO 123
C LEFT FACING VERTICAL SURFACE, VN(I,1) < 0.
      XMN(I)=XMX(I-1)
      TEMP=IMAX(I)-IMIN(I)+1
      TEMP=TEMP/2.0
      XMX(I)=XMN(I)+TEMP
      GO TO 129
C RIGHT FACING VERTICAL SURFACE.
 123  XMX(I)=XMN(I-1)
      TEMP=IMAX(I)-IMIN(I)+1
      TEMP=TEMP/2.0
      XMN(I)=XMX(I)-TEMP
 129  CONTINUE
C LOWEST EDGE OF THE LAST LINING SURFACE, I=LSN, MEETS THE FLOOR
C SO  XMN(LSN) = 0.
      XMN(LSN)=0.
      RETURN
      END
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      SUBROUTINE RDIGTN
C -----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) READ IN DATA DESCRIBING THE IGNITION SOURCE FIRE.
C (2) INITIALIZE VARIABLES CONCERNED WITH THE IGNITION SOURCE.
C COMMENTS
C (1) A LIMITED CAPABILITY TO SET LINING SURFACE ELMNTS TO AN INERT
C     STATE BY INITIALIZING THEM TO STATE 4 IS INCLUDED.
C -----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
C READ CARD TYPE 37. IGNITION FUEL CHARACTERISTICS AND AMOUNT.
      READ(5, 2) GCI, GAMI, WMIGF, RHOI, XMUI, RADI, XMFI
C READ CARD TYPE 38. IGNITION FUEL HEAT RELEASE RATE. RAMP-IN TIME.
      READ(5, 2) DGI, RAMPT
C READ CARD TYPE 39. IGNITION FUEL SMOKE AND GAS PRODUCTION RATES
      READ(5, 2) RSI, (RTGI(I), I=1, NTXG)
C CONVERT GAS PRODUCTION RATES FROM MICROLBM/(FT*FT*S) TO LBM/(FT*FT*S)
      DO 9 M=1, NTXG
    9 RTGI(M)=RTGI(M)*1.E-6
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C READ CARD TYPE 40, INGITION SURFACE NUMBER
      READ(5,1) IGSN
    2 FORMAT(8F10.1)
C READ CARD TYPE 41, NUMBER OF IGN ELMNTS AND IGN FIRE BASE PERIMETER.
      READ(5,4) NIJSQ,PIGN
  4   FORMAT(I5,F10.1)
  1   FORMAT(2I5)
C SET THE FLAG IBURN TO 1 TO SHOW THAT THE IGN FIRE IS BURNING; COMPUTE
C THE TOTAL BASE AREA OF THE FIRE, AFI; AND THE BURNING TIME, TBURNI, IN
C SECONDS.
      IBURN=1
      AFI=NIJSQ*SQD*SQD
      IRAMPT = 1000. * RAMPT
      TBURNI = 0.5 * RAMPT + XMFI / (AFI * RHOI * XMUI)
C SET THE NUMBER OF FLAMING ELMNTS ON THE IGN SURF TO THE NUMBER OF IGN
C FIRE ELMNTS. SET ITFCP FOR LATER PACKING, AND COMPUTE THE OXYGEN
C CONSUMPTION FACTOR FOR THE IGN FIRE. ADJUST THE GROSS HEAT OF COMBUS-
C TION OF THE IGN SRC FUEL BY THE RADIATION LOSS FACTOR.
      NFE(IGSN)=NIJSQ
      ITFCP=TBURNI+.00001
      FOXI=QCI/GAMI
      QCI=QCI*(1.-RADI)
C
C COMMPUTE THE INITIAL RATES OF HEAT, SMOKE, AND GAS GENERATION AND
C  OXYGEN CONSUMPTION FOR THE IGNITION SOURCE FIRE
C
      FCTR = 1. / ( 1. + RAMPT / DELTAT )
      DQI  = FCTR * DQI
      RSI  = FCTR * RSI
      DO 3 M = 1 , NTXG
  3   RTGI(M) = RTGI(M) * FCTR
      FOXI = FOXI * FCTR
C
C THE NEXT 9 STMTS SET UP THE ISTATE OR ISTATS ARRAY MEMBERS FOR IGN SRC
C ELEMENTS AFTER THE I AND J INDICES  OF EACH ELEMENT IS READ.
      DO 10 KK=1,NIJSQ
C READ CARD TYPE 42, IGN SRC FIRE ELEMENT I AND J INDICES.  THESE
C INDICES  ARE STORED IN THE ARRAY IGNIJ FOR LATER USE.
      READ(5,1) (IGNIJ(I,KK),I=1,2)
      II=IGNIJ(1,KK)
      JJ=IGNIJ(2,KK)
C IF THE IGNITION SURFACE IS A SEAT, GO TO STMT 5 TO SET UP ISTATS.
      IF(IGSN.GT.LSN) GO TO 5
C IGNITION SURFACE IS A LINING SURFACE, SET UP ISTATE FOR THIS I AND J.
      ISTATE(II,JJ)=ITFCP*100+33
      GO TO 10
  5   IS=IGSN-LSN
      ISTATS(IS,II,JJ)=ITFCP*100+33
 10   CONTINUE
C THE NEXT 10 STMTS SCAN THE ARRAY IGNIJ TO FIND THE MAXIMUM AND MINIMUM
C VALUES OF THE IGN SRC ELMNT I AND J VALUES AND SAVE THEM IN THE
C VARIABLES IGMNI, ETC.  THESE ARE USED LATER TO ISOLATE THE IGN SRC.
      IGMNI=200
      IGMXI=-1
      IGMNJ=200
      IGMXJ=-1
      DO 15 KK=1,NIJSQ
      IF(IGNIJ(1,KK).LT.IGMNI) IGMNI=IGNIJ(1,KK)
      IF(IGNIJ(1,KK).GT.IGMXI) IGMXI=IGNIJ(1,KK)
      IF(IGNIJ(2,KK).LT.IGMNJ) IGMNJ=IGNIJ(2,KK)
      IF(IGNIJ(2,KK).GT.IGMXJ) IGMXJ=IGNIJ(2,KK)
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 15   CONTINUE
C READ CARD TYPE 43, NUMBER OF ELMNTS TO BE SET TO CHARRED (INERT) STATE
      READ(5,1) NIJC
      IF(NIJC.EQ.0) GO TO 30
      DO 20 KK=1,NIJC
C READ CARD TYPE 44, I AND J INDICES  OF CHARRED ELEMENTS
      READ(5,1)I,J
C FIND THE SURFACE ON WHICH THIS ELMNT LIES AND INCREASE NCE, THEN
C SET THE VALUE OF ISTATE(I,J) TO INDICATE THIS ELMNT IS INERT.
      II=IRAY(I)
      NCE(II)=NCE(II)+1
      CALL CVOUT(I,J,1,IST,ISTP,ITFCP)
      ISTATE(I,J)=44
 20   CONTINUE
C
 30   CONTINUE
C
C READ CARD TYPE 45, VENT NUMBER AT WHICH THERE IS AN EXTERIOR FIRE
C  IF THERE IS NO SUCH FIRE, RETURN
C
      READ(5,1) IFRVNT
C
      IF(IFRVNT .EQ. 0) RETURN
C
C READ CARD TYPE 46, DESCRIPTION OF FIRE GASES AND FLOW RATES
C
      READ(5,35) RHOEFG, TEFG, FLOWIN, FLWOUT
 35   FORMAT(8F10.1)
C
C READ CARD TYPE 47, COMPOSITION OF EXTERIOR FIRE GASES
      READ(5,35) (CHIEFG(N),N=1,NSPCS)
C
      RETURN
      END
```

```
      SUBROUTINE ECHO
C
C -------------------------------------------------------------------
C OBJECTIVE(S)
C (1) ECHO INPUT DATA FOR ERROR CHECKING.
C COMMENTS
C (1) "ECOFLG" = 0 RESULTS IN A RETURN WITH ONLY TITLE AND CASE ID
C     PRINTED.
C (2) MOST WRITE STMTS ARE SELF-EXPLANITORY, SO FEW COMMENTS HAVE BEEN
C     ADDED FOR THEM.
C -------------------------------------------------------------------
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1              IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2              ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3              JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1              IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2              RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3              TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4              ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5              FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6              IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7              IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8              JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9              NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1              RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2              TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3              FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4              TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1              RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2              VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3              JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1              IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2              CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3              ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4              ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5              ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6              IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7              SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8              XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9              HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1              CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2              FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1              FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2              ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3              ITPE(20), ITPES(7), ITPS(7), QCI, GP(7), GTAB(7), RHOI,
     4              RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5              XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6              WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      INTEGER ECOFLG
C
C WRITE THE RUN ID
C
      WRITE(6, 8)(IDENT(M), M=1, 20)
```

```
 8    FORMAT(1H1//45X,14HPROGRAM DACFIR,5X,22HVERSION 3.0--1 APR 81 //33
     1X,61HCOMPUTER SIMULATION OF FIRE WITHIN A TRANSPORT AIRCRAFT CABIN
     2//26X,10HDATA CASE:,5X,20A4)
      IF(ECOFLG.LE.0)RETURN
C
C WRITE THE TIME AND NUMERICS CONTROL DATA
C
      WRITE(6,10) DELTAT,TFINAL,EPSLN,MAXITR,MAXCUT,JCBSKP,IRATIO,ISCALE
```

```
 10   FORMAT(//51X,27HINPUT SUMMARY ( ECOFLG = 1)/2X,20HPROGRAM CONTROL
     *DATA//3X,18HTIME STEP (SEC) = ,F7.3,2X,18HSTOP TIME (SEC) = ,F8.3,
     *2X,18HCONV. TOLERANCE = ,F8.6,2X,17HMAX ITERATIONS = ,I3,2X,19HMAX
     * STEP CUT LVL = ,I3//3X,22HJACOBIAN SKIP CNTRL = ,I2,2X,34HPASS RA
     *TIO FOR FLAME SPRD CALCS = ,I5,2X,26HSCALE FACTOR EVAL CNTRL = ,
     *I5)
C
C WRITE OUTPUT CONTROL DATA.
C
      IIPEMS = IPEMS / 1000
      IIPSPR = IPSPR / 1000
      IIPAUX = IPAUX / 1000
      WRITE(6,11) IIPEMS,IIPSPR,IIPAUX
 11   FORMAT(/3X,36HCABIN ATMS DATA PRNT INTRVL (SEC) = ,I5,2X,36HFLAME
     *SPRD DATA PRNT INTRVL (SEC) = ,I5,2X,35HAUXILLARY DATA PRNT INTRVL
     * (SEC) = ,I5)
C
C WRITE THE CABIN HEIGHT, WIDTH, NUMBER OF COMPARTMENTS, AND COMP. NO.
C  FOR ANY INTERIOR FIRES.
C
      WRITE(6,12) CH, CW, NCOMPS, IFRCMP
 12   FORMAT(/2X,19HCABIN GEOMETRY DATA//3X,29HMAX HEIGHT AT CEILING (FT
     *) = ,F6.1,2X,22HWIDTH AT FLOOR (FT) = ,F6.1,2X,25HNUMBER OF COMPAR
     *TMENTS = ,I2,2X,19HFIRE COMPARTMENT = ,I2)
C
C WRITE THE COMPARTMENT LENGTH(S)
C
      WRITE(6,13) (I,CL(I),I=1,NCOMPS)
 13   FORMAT(/3X,26HCOMPARTMENT LENGTH(S) (FT),
     *4(8H    NO = ,I2,7H LTH = ,F5.1))
C
C WRITE THE NUMBER OF SURFACES, NUMBER OF SEAT GROUPS, AND CEILING DEFN.
C
      WRITE(6,14) LSN,NSG,ICLL,ICLR
 14   FORMAT(/3X,25HNUMBER LINING SURFACES = ,I3,3X,21HNUMBER SEAT GROUP
     *S = ,I3,3X,23HLEFT CEILING SURFACE = ,I2,3X,24HRIGHT CEILING SURFA
     *CE = ,I2)
C
C WRITE THE LINING SURFACE DESCRIPTIONS.
C
      WRITE(6,15)
 15   FORMAT(/3X,19HLINING SURFACE DATA//5X,10HSRF NUMBER,3X,10HWIDTH (F
     *T),3X,13HDSPLCMNT (FT),3X,19HNORMAL VCTR (I,J,K),3X,18HMATERIAL TY
     *PE CODE/)
C
      DO 16 I=1,LSN
 16   WRITE(6,17) I,SWD(I),Z(I),(VN(I,J),J=1,3),IMATL(I)
 17   FORMAT(9X,I2,11X,F5.1,9X,F5.1,5X,F6.3,1X,F6.3,1X,F6.3,10X,I2)
C
C WRITE THE SEAT GROUP DATA
C
      WRITE(6,18)
 18   FORMAT(1H1///3X,15HSEAT GROUP DATA//4X,25HGROUP NUMBER   WIDTH (FT
     *),3X,35HCORNER POINT COORDINATES (X,Y) (FT)//)
C
      DO 19 I=1,NSG
 19   WRITE(6,20)I,SGWD(I),XCOR(I),YCOR(I)
 20   FORMAT(9X,I2,10X,F5.1,17X,F5.1,3X,F5.1)
C
C WRITE THE SEAT SURFACES MATERIAL CODES
C
```

```
      WRITE(6,21) (IMATS(I),I=1,7)
 21   FORMAT(/4X,45HSEAT SURFACE MATERIAL CODES SURF/CODE     1 / ,I2,7H
     *  2 / ,I2,7H   3 / ,I2,7H   4 / ,I2,7H   5 / ,I2,7H   6 / ,I2,7H
     * 7 / ,I2)
C
C WRITE THE SEAT-TO-SIDEWALL SPREAD PARAMETERS AND PARTN MATL CODES,
C  AND NUMBER OF VENTS.
C
      WRITE(6,22) DWS,RFWS,(IMTLP(I),I=1,NCOMPS),NV
 22   FORMAT(/3X,51HSEAT-TO-SIDEWALL SPREAD PARAMETERS DISTANCE (FT) = ,
     *F5.1,2X,16HRATE (FT/SEC) = ,F5.1//3X,42HPARTITION MATERIAL CODES C
     *OMP/CODE     1 / ,I2,7H    2 / ,I2,7H    3 / ,I2,7H    4 / ,I2//3X,
     *53HVENT DATA NUMBER OF VENTS (TOTAL ALL COMPARTMENTS) = ,I3)
C
C WRITE THE DATA FOR EACH VENT
C
      WRITE(6,23)
 23   FORMAT(/4X,11HVENT NUMBER,2X,29HCONNECTS CMPRTMNT TO CMPRTMNT,2X,
     *8HTOP (FT),2X,11HHEIGHT (FT),2X,10HWIDTH (FT),2X,14HSET FLOW (CFM)
     *,2X,20HINTO CMPRTMNT NUMBER/)
C
      DO 24 K=1,NV
      I1 = CNCTNS(K) / 10.
      I2 = CNCTNS(K) - I1 * 10
 24   WRITE(6,25) K,I1,I2,VENTT(K),VENTH(K),VENTW(K),FLOW(K),INTO(K)
 25   FORMAT(8X,I2,18X,I2,10X,I2,7X,F5.1,5X,F5.1,8X,F5.1,7X,F8.2,
     *15X,I2)
C
C START A NEW PAGE AND WRITE THE NUMBER OF MATLS AND TRACE GASES
C
      WRITE(6,26)NMATLS,NTXG
 26   FORMAT(1H1//2X,14HMATERIALS DATA//3X,22HNUMBER OF MATERIALS = ,
     *I2,3X,30HNUMBER OF TRACE GAS SPECIES = ,I2//3X,11HGAS SPECIES,
     *6X,6HSYMBOL,5X,16HMOLECULAR WEIGHT)
C
C WRITE GAS SPECIES AND MOLECULAR WEIGHTS
C
      WRITE(6,27)(I,NGAS(I),WMOLEC(I),I=1,NSPCS)
 27   FORMAT(/5X,I2,14X,A4,9X,F8.3)
C
C WRITE COMBUSTION PARAMETERS
C
      WRITE(6,28)
 28   FORMAT(/3X,21HCOMBUSTION PARAMETERS//4X,4HMATL,2X,
     *18HHEAT OF COMBUSTION,2X,21HSTOICH OXY/FUEL RATIO,
     *2X,9HMOLEC WGT,2X,18HPYROLYZATE DENSITY,2X,
     *19HPYROLYZATE VELOCITY,2X,17HRADIATED FRACTION/13X,
     *9H(BTU/LBM),46X,11H(LBM/CU FT),10X,8H(FT/SEC))
C
      WRITE(6,29)(I,QTAB(I),GTAB(I),WMMTL(I),RTAB(I),UTAB(I),RADTAB(I),
     *            I=1,NMATLS)
 29   FORMAT(/5X,I2,4X,F10.3,14X,F8.3,11X,F7.3,7X,F8.5,12X,F8.3,12X,
     *F8.5)
C
C WRITE SMOLDERING STATE DATA
C
      NXX = 5 + NTXG
      WRITE(6,30)(NGAS(I),I=6,NXX)
 30   FORMAT(/3X,21HSMOLDERING STATE DATA//4X,4HMATL,2X,12HSMLDG TRSHLD,
     *2X,16HTRNSTN TO SMLDRG,2X,14HTRNSTN TO CHRD,2X,14HSMK PRODN RATE,
     *9X,36HGAS PRODUCTION RATES (LBM/SQ FT-SEC)/9X,15H(BTU/SQ FT-SEC),
```

```
     *5X, 5H(SEC), 13X, 5H(SEC), 8X, 10H(PART/SEC), 5(7X, A4)/)
C
      DO 31 I=1, NMATLS
 31   WRITE(6,32)I, QP(I), TP(I), TPC(I), RSS(I), (RGS(IG, I), IG=1, NTXG)
 32   FORMAT(5X, I2, 4X, F8.3, 8X, F8.3, 10X, F8.3, 7X, F8.3, 6X, 5(E10.4, 1X))
C
C WRITE FLAMING STATE DATA - ORDER IS (1) HORIZONTAL FLAME SPREAD RATE,
C  (2) UPWARD FLAME SPREAD RATE, (3) DOWNWARD FLAME SPREAD RATE,
C  (4) TIME TO IGNITE, (5) HEAT RELEASE RATE, (6) SMOKE RELEASE RATE,
C  (7) SMOLDERING LAG TIME, (8) TIME TO BURN OUT, (9) RELEASE RATE OF
C  THE FIRST TRACE GAS, (10) RELEASE RATE OF THE SECOND TRACE GAS,...
C  (13) RELEASE RATE OF THE FIFTH TRACE GAS. START ON NEW PAGE
C
      WRITE(6,33)
 33   FORMAT(1H1//3X, 18HFLAMING STATE DATA, 4X, 27HALL FLUXES IN BTU/SQ FT
     *-SEC//4X, 47HHORIZONTAL FLAME SPREAD RATE - VALUES IN FT/SEC)
      WRITE(6,34)
 34   FORMAT(/5X, 4HMATL, 2X, 6(4HFLUX, 4X, 5HVALUE, 6X))
      WRITE(6,35)(I, (TABX(1, I, IX), TABY(1, I, IX), IX=1,6), I=1, NMATLS)
 35   FORMAT(/5X, I2, 3X, F6.2, 2X, F8.4, 3X, F6.2, 2X, F8.4, 3X, F6.2, 2X, F8.4,
     *              3X, F6.2, 2X, F8.4, 3X, F6.2, 2X, F8.4, 3X, F6.2, 2X, F8.4)
C
      WRITE(6,36)
 36   FORMAT(/4X, 43HUPWARD FLAME SPREAD RATE - VALUES IN FT/SEC)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(2, I, IX), TABY(2, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,37)
 37   FORMAT(/4X, 45HDOWNWARD FLAME SPREAD RATE - VALUES IN FT/SEC)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(3, I, IX), TABY(3, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,38)
 38   FORMAT(/4X, 34HTIME TO IGNITE - VALUES IN SECONDS)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(4, I, IX), TABY(4, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,39)
 39   FORMAT(/4X, 43HHEAT RELEASE RATE - VALUES IN BTU/SQ FT-SEC)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(5, I, IX), TABY(5, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,40)
 40   FORMAT(/4X, 50HSMOKE RELEASE RATE - VALUES IN PARTICLES/SQ FT-SEC)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(6, I, IX), TABY(6, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,41)
 41   FORMAT(/4X, 39HSMOLDERING LAG TIME - VALUES IN SECONDS)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(7, I, IX), TABY(7, I, IX), IX=1,6), I=1, NMATLS)
C
      WRITE(6,42)
 42   FORMAT(/4X, 36HTIME TO BURN OUT - VALUES IN SECONDS)
      WRITE(6,34)
      WRITE(6,35)(I, (TABX(8, I, IX), TABY(8, I, IX), IX=1,6), I=1, NMATLS)
C
      NXY = 8 + NTXG
      DO 46 JJ = 9, NXY
      JJJ = JJ - 3
      WRITE(6,43) NGAS(JJJ)
```

```
 43   FORMAT(/4X,16HRELEASE RATE OF ,A4,26H - VALUES IN LBM/SQ FT-SEC)
      WRITE(6,44)
 44   FORMAT(/5X,4HMATL,1X,6(4HFLUX,5X,5HVALUE,6X))
      WRITE(6,45)(I,(TABX(JJ,I,IX),TABY(JJ,I,IX),IX=1,6),I=1,NMATLS)
 45   FORMAT(/5X,I2,2X,F6.2,1X,E11.4,2X,F6.2,1X,E11.4,2X,F6.2,1X,E11.4,
     *                2X,F6.2,1X,E11.4,2X,F6.2,1X,E11.4,2X,F6.2,1X,E11.4)
 46   CONTINUE
C
C WRITE BULK THERMAL PROPERTIES OF MATERIALS
C
      WRITE(6,47)
 47   FORMAT(/3X,31HTHERMAL PROPERTIES OF MATERIALS//
     *4X,4HMATL,3X,13HHEAT CAPACITY,5X,11HAVG DENSITY,5X,14HLINING SURFA
     *CE,3X,13HTHERML CONDCT,5X,10HINSULATION/12X,11H(BTU/LBM*R),5X,
     *14HLBM/(FT*FT*FT),3X,13HTHICKNSS (FT),4X,14HBTU/(FT-SEC-R),3X,
     *13HTHICKNSS (FT))
C
      WRITE(6,48)(M,CPM(M),RHOM(M),TKNS(M),CNDCTY(M),TKNSIN(M),
     *            M=1,NMATLS)
 48   FORMAT(7(/5X,I2,5(4X,E13.6)))
C
C WRITE AMBIENT TEMPERATURE AND PRESSURE
C
      WRITE(6,49)TAM,PAMB
 49   FORMAT(/16X,26HAMBIENT TEMPERATURE (R) = ,F10.3,11X,
     *            31HAMBIENT PRESSURE (LBF/SQ FT) = ,F10.3)
C
C WRITE IGNITION FUEL CHARACTERISTICS
C
      WRITE(6,50)GCI,GAMI,WMIGF,RHOI,XMUI,RADI,XMFI
 50   FORMAT(1H1//3X,29HIGNITION FUEL CHARACTERISTICS//
     *4X,28HHEAT OF COMBSTN (BTU/LBM) = ,F10.4,18X,24HSTOICH OXY/FUEL RA
     *TIO = ,F10.4//23X,19HMOLECULAR WEIGHT = ,F10.4,9X,
     *33HVAPOR DENSITY (LBM/(FT*FT*FT)) = ,F10.6//4X,38HMASS BURNING RAT
     *E (LBM/(FT*FT*SEC)) = ,F10.7,7X,25HFLAME RADIATION FACTOR = ,
     *F10.4//13X,29HTOTAL AMOUNT OF FUEL (LBM) = ,F10.4)
C
      RAMPT = IRAMPT / 1000.
      WRITE(6,51)DGI,RAMPT,RSI,(RTGI(I),I=1,NTXG)
 51   FORMAT(/12X,38HHEAT RELEASE RATE (BTU/(FT*FT*SEC)) = ,
     *F10.4,27X,21HRAMP-IN TIME (SEC) = ,F10.4//4X,38HSMK PROD RATE (PAR
     *TCLS/(FT*FT*SEC)) = ,E13.6//4X,31HGAS PROD RATE (LBM/(FT*FT*SEC))/
     *4X,5(E13.6,8X))
C
      WRITE(6,52)IGSN,NIJSG,PIGN
 52   FORMAT(//3X,16HIGNTN SURF NO = ,I2,7X,21HNO OF IGNTN ELMNTS = ,I3,
     *7X,33HIGNTN FIRE BASE PERIMETER (FT) = ,F10.4)
C
C SHOW THE IGN SRC LOCATION THRU THE IGN SRC ELMNT INDICES.
C
      WRITE(6,53)(IGNIJ(1,KK),IGNIJ(2,KK),KK=1,NIJSG)
 53   FORMAT(//20X,34HELEMEMTS AFLAME---        I        J/(44X,I2,6X,I2))
C
C WRITE MESSAGE IDENTIFYING SURFACE NUMBERING SEQUENCE.
C
 55   WRITE(6,60)ICLR,ICLL,LSN,JMAX(1)
 60   FORMAT(//20X,79HLOOKING FROM THE FRONT OF THE CABIN TOWARD  THE RE
     1AR,THE FLOOR IS SURFACE NO 1,/20X,69HTHE LWR RGT SIDEWALL IS SURFA
     2CE NO 2,THE RGT SIDE CEILING SURFACE IS ,I2,5H, THE/20X,29HLEFT SI
     3DE CEILING SURFACE IS ,I2,41H,AND THE LWR LEFT SIDEWALL IS SURFACE
     4 NO ,I2//20X,79HTHE ELEMENTS(IN THE I DIRECTION)ARE NUMBERED IN TH
```

```
     5E SAME MANNER AS THE SURFACES/20X,57HTHE FRONT MOST ELEMENT IS J=1
     6,THE REAR MOST ELEMENT IS J=,I2)
C
C WRITE SURFACE DESCRIPTIONS BY SURFACE NUMBER.
C
      WRITE(6,70)(I,SWD(I),Z(I),(VN(I,J),J=1,3),IMATL(I),IMIN(I),IMAX(I)
     1,XMN(I),XMX(I),I=1,LSN)
 70   FORMAT(//13X,105HSURFACE DATA(EXCL SEATS)---  SURF NO  WIDTH,FT
     1HGT,FT    UNIT NORM      MATL TYPE     IMIN   IMAX   XMN   XMX/(45X,I2,5
     2X,F5.1,6X,F5.1,3F5.1,6X,I1,9X,I2,4X,I2,1X,2F5.1))
C
C WRITE SEAT GROUP IDS, DIMENSIONS, AND LOCATIONS.
C
      WRITE(6,80)(IS,SGWD(IS),XCOR(IS),YCOR(IS),IS=1,NSG)
 80   FORMAT(1H1/10X,17HSEAT GROUP DATA--,29X,8HLOCATION/30X,39HST GRP N
     1O   WIDTH,FT    XCOR,FT    YCOR,FT/(35X,I1,7X,F5.1,5X,F5.1,5X,F5.1))
C
C IDENTIFY MATERIAL OF EACH SEAT GROUP SURFACE. ALL SEAT GROUPS ARE OF
C IDENTICAL CONSTRUCTION.
C
      WRITE(6,90)(IMATS(M),M=1,7)
 90   FORMAT(/15X,31HEACH SEAT GROUP HAS 7 SURFACES:,4X,7HSURF NO,6X,7HS
     1URFACE,6X,9HMATL TYPE/53X,19H1     CUSHION BOTTOM,8X,I1/53X,22H2
     2 LWR REAR BACKREST,5X,I1/53X,22H3     UPR REAR BACKREST,5X,I1/53X,2
     30H4     TOP OF BACKREST,7X,I1/53X,22H5     FRONT OF BACKREST,5X,I1/5
     43X,16H6     CUSHION TOP,11X,I1/53X,18H7     CUSHION FRONT,9X,I1)
C
C THE NEXT 13 STMTS PRODUCE THE OVERHEAD VIEW OF THE SEAT GROUPS
C SUPERIMPOSED ON THE FLOOR.
C
      I1=IMAX(1)
      I2=CW+TOL
      IX=I2+1
      WRITE(6,100)
 100  FORMAT(/15X,83HOVERHEAD VIEW OF SEATS SUPERIMPOSED ON FLOOR(NON-ZE
     1RO INTEGER IS SEAT GROUP NUMBER))
      DO 115 N=1,I2
      IX=IX-1
      WRITE(6,110)IX,(IARX(L,IX),L=1,I1)
 110  FORMAT(22X,I2,1X,40I1)
 115  CONTINUE
      WRITE(6,120)
 120  FORMAT(25X,5HFRONT)
      WRITE(6,180)
 180  FORMAT(/////10X,20HEND OF INPUT SUMMARY)
      RETURN
      END
```

```
      SUBROUTINE OUTPUT(IPR1, IPR2, STATS, NDXS)
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) OUTPUT OF THE SIMULATION.  CABIN ATMOSPHERE AND FLAME SPREAD DATA
C COMMENTS
C (1) THIS SUBR CONSISTS OF TWO MAJOR PARTS: STMTS TO NUMBER 40 WHICH
C     REPORT THE ATMOSPHERE DATA, AND STMTS AFTER 40 WHICH REPORT THE
C     FLAME SPREAD DATA.  THESE TWO PARTS MAY BE EXECUTED SEPARATELY AS
C     CONTROLLED BY THE FLAGS IPR1 AND IPR2.  IPR1=0 => PRINT GAS DATA
C     AND IPR2=0 => PRINT FLAME SPRD DATA.
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, QC(2)
      COMMON /PRTCMN/ ASRFUZ(22, 4), ASRFLZ(22, 4), CVFLWU(22, 4),
     *                CVFLWL(22, 4), RDFLWU(22, 4), RDFLWL(22, 4),
     *                VTFLWV(24, 2), VTFLWE(24, 2), FBVDOT(30),
     *                FBSDOT(11, 30), FBQDOT(30), FRENTR(30)
      DIMENSION IO(12), IDATA(7), IND1(10), IND2(10), IND3(10), CONC(10),
     1          IZN(2), ISURF(120, 15), ISSURF(40), FTU(5), FTL(5), XPF(5)
      DIMENSION LNSRFN(120), LNSRFC(120), STATS(50, 2), PPMU(10), PPML(10)
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      DIMENSION NWRD(22),IGRPDF(7,5),NA(8),N[illegible]L(20,2,4),
     1          FTSP(2,2,4),SMKU(5),SMKL(5)
      LOGICAL LNUNDR(22)
C ARRAYS IO, IDATA, AND IZN CONTAIN CHARACTER DATA FOR FORMATTING.
      DATA IO/4H(10X,1H,,3H1X),4H1H ,,4H,1X),4H2HCF,4H2HCT,4H2HBF,4H2HBT
     1        ,4H2HBU,4H2HBL,4H2HCB/
      DATA IDATA/4H1H ,,4H1HS,,4H1HF,,4H1HC,,4H1H ,,4H1H ,,4H1H ,/
      DATA IZN/3HLWR,3HUPR/
      DATA LNUNDR/.TRUE.,2*.FALSE.,.TRUE.,5*.FALSE.,2*.TRUE.,3*.FALSE.,
     &            .TRUE.,2*.FALSE.,.TRUE.,3*.FALSE.,.TRUE./
      DATA NWRD/1,0,2,0,0,0,3,0,0,0,4,0,5,0,0,0,6,0,0,7,0,0/
      DATA IGRPDF/4H  CU,4H  CU,4H  BA,4H  BA,4H  BA,4H  BA,4H  CU,
     &            4HSHIO,4HSHIO,4HCKRE,4HCKRE,4HCKRE,4HCKRE,4HSHIO,
     &            4HN,FR,4HN,TO,4HST,F,4HST,T,4HST,U,4HST,L,4HN,BO,
     &            4HONT ,4HP   ,4HRONT,4HOP  ,4HPR R,4HWR R,4HTTOM,
     &            4H    ,4H    ,4H    ,4H    ,4HEAR ,4HEAR ,4H    /
      DATA T460/459.67/
C
C IF NEITHER IPR1 OR IPR2 IS = 0, NO OUTPUT IS TO BE DONE, SO RETURN
C
      IF(IPR1.NE.0.AND.IPR2.NE.0)GO TO 500
C
C CONVERT TIME TO SECONDS AND WRITE TIME MESSAGE AT TOP OF PAGE.
C
      TIME=ITIME/THOU
C
C WRITE TIME AND RUN ID AT THE TOP OF A NEW PAGE
C
      WRITE(6,2) TIME, (IDENT(M),M=1,20)
 2    FORMAT(1H1/ 5X,6HTIME= ,F9.3,8H SECONDS,13X,20A4)
C
      DO 24 ICMP=1,NCOMPS
C CONVERT GAS TEMPERATURES TO FAHRENHEIT
C
      FTU(ICMP) = TU(ICMP) - T460
      FTL(ICMP) = TL(ICMP) - T460
C
C CONVERT PRESSURE TO LBF/SQ FT AND SMOKE TO OD/FT
C
      XPF(ICMP) = PF(ICMP) / GRAV
      SMKU(ICMP) = 0.0457575 * CHIU(NSPCS,ICMP) * RHOU(ICMP)
      SMKL(ICMP) = 0.0457575 * CHIL(NSPCS,ICMP) * RHOL(ICMP)
C
      WRITE(6,3)
 3    FORMAT(///2X,11HCOMPARTMENT,2X,4HZONE,4X,5HDEPTH,4X,6HVOLUME,3X,
     1       8HGAS TEMP,2X,11HGAS DENSITY,2X,10HSMOKE CONC,2X,
     2       29HMASS FRACTIONS OF MAJOR GASES,2X,8HPRESSURE/23X,4H(FT),
     3       5X,7H(CU FT),4X,3H(F),5X,11H(LBM/CU FT),3X,7H(OD/FT),7X,
     4       2HO2,7X,3HCO2,7X,3HH2O,5X,11H(LBF/SQ FT)/)
      XX = CH - ZD(ICMP)
      WRITE(6,4) ICMP, XX, VOLU(ICMP), FTU(ICMP), RHOU(ICMP),
     1   SMKU(ICMP)   , CHIU(2,ICMP), CHIU(4,ICMP), CHIU(5,ICMP),
     2 XPF(ICMP), ZD(ICMP), VOLL(ICMP), FTL(ICMP), RHOL(ICMP),
     3   SMKL(ICMP)   , CHIL(2,ICMP), CHIL(4,ICMP), CHIL(5,ICMP)
 4    FORMAT(7X, I1, 7X, 6HUPPER , F8.3, 1X, F8.1, 3X, F8.2, 3X, F8.5,
     1 4X, F7.3, 2X, 3(2X,F8.5), 5X, F8.2/ 15X, 6HLOWER , F8.3, 1X,
     2 F8.1, 3X, F8.2, 3X, F8.5, 4X, F7.3, 2X, 3(2X, F8.5)/)
C
      IXS = NSPCS - 1
      WRITE(6,5) (NGAS(IG),IG=1,IXS)
 5    FORMAT(1X,34HZONE      GAS CONCENTRATIONS  (PPM)/13X,
```

```
     1        10(A4, 5X))
C
C CONVERT   GAS CONCENTRATIONS FROM MASS FRACTION TO PPM BY VOLUME
C
      SUML = 0.
      SUMU = 0.
C
      DO 6 IG=1, IXS
      SUML = SUML + CHIL(IG, ICMP) / WMOLEC(IG)
 6    SUMU = SUMU + CHIU(IG, ICMP) / WMOLEC(IG)
C
      DO 7 IG=1, IXS
      PPML(IG) = 0.
      PPMU(IG) = 0.
      IF(SUML .GT. 0. ) PPML(IG) = CHIL(IG, ICMP)/(SUML * WMOLEC(IG))
      IF(SUMU .GT. 0. ) PPMU(IG) = CHIU(IG, ICMP)/(SUMU * WMOLEC(IG))
      PPML(IG) = PPML(IG) * 1.E+6
 7    PPMU(IG) = PPMU(IG) * 1.E+6
C
      WRITE(6, 8) (PPMU(IG), IG=1, IXS)
 8    FORMAT(1X, 5HUPPER, 2X, 10F9.0)
      WRITE(6, 9) (PPML(IG), IG=1, IXS)
 9    FORMAT(1X, 5HLOWER, 2X, 10F9.0 )
C
C IF THIS IS THE COMPARTMENT WITH INTERIOR FIRES PRINT THE FIRE DATA
C
      IF( ICMP .NE. IFRCMP ) GO TO 17
      IF( NFIRES .EQ. 0 ) GO TO 17
      WRITE(6, 10)
 10   FORMAT(/1X, 14HINTERIOR FIRES/
     *       2X, 53HFIRE  BASE AREA  VAPOR GEN RATE  HEAT GEN RATE  PLUME
     1         , 53H ENTRMNT  FLAME LENGTH  ABSN COEFF  SMOKE GEN RATE  O
     2         , 14HXY CNSPTN RATE/
     3       9X, 53H(SQ FT)     (CU FT/SEC)      (BTU/SEC)      (CU FT/SEC)
     4         , 53H        (FT)         (1/FT)      (PART/SEC)        (LBM/S
     5         ,  3HEC) )
C
      DO 12 N=1, NFIRES
      IXS = NTXG + 6
      WRITE(6, 11) N, AF(N), FBVDOT(N), FBQDOT(N), FRENTR(N), FLML(N),
     1               ABSCF(N), FBSDOT(IXS, N), FBSDOT(2, N)
 11   FORMAT(2X, I3, 2X, F8.2, 5X, E13.6, 2X, E13.6, 2X, E13.6, 4X, F8.2, 2X, E13.6,
     1 1X, E13.6, 3X, E13.6)
 12   CONTINUE
C
      WRITE(6, 13)
 13   FORMAT(/8X, 36HTRACE GAS GENERATION RATES (LBM/SEC) )
C
      IXS = 5 + NTXG
      WRITE(6, 14) (NGAS(IG), IG = 6, IXS )
 14   FORMAT(2X, 4HFIRE, 7X, 5(A4, 11X))
C
      DO 16 N = 1, NFIRES
      WRITE(6, 15) N, (FBSDOT(IG, N), IG = 6, IXS )
 15   FORMAT(2X, I3, 3X, 5(E13.6, 2X))
 16   CONTINUE
C
 17   CONTINUE
C
C WRITE THE SURFACE TEMPERATURE AND HEAT FLUX DATA
C
```

```
      WRITE(6,18)
 18   FORMAT(/1X,18HSURFACE CONDITIONS/
     *         2X,52HSURFACE      CONTACT AREA (SQ FT)       CONVECTIVE FLOW
     1           ,52H(BTU/SEC)          RADIATIVE FLOW (BTU/SEC)          TEM
     2           ,12HPERATURE (F)/
     3        11X,52HUPPER ZONE  LOWER ZONE      UPPER ZONE  LOWER ZONE
     4           ,52H         UPPER ZONE   LOWER ZONE       UPPER PART  LOWE
     5           ,6HR PART)
C
      DO 20 ISRF = 1, LSN
C
C CONVERT LINING SURFACE TEMPERATURES TO FAHRENHEIT
C
      FTSL(ISRF,2,ICMP) = TSL(ISRF,2,ICMP) - T460
      FTSL(ISRF,1,ICMP) = TSL(ISRF,1,ICMP) - T460
      WRITE(6,19) ISRF, ASRFUZ(ISRF,ICMP), ASRFLZ(ISRF,ICMP),
     1                  CVFLWU(ISRF,ICMP), CVFLWL(ISRF,ICMP),
     2                  RDFLWU(ISRF,ICMP), RDFLWL(ISRF,ICMP),
     3                  FTSL(ISRF,2,ICMP), FTSL(ISRF,1,ICMP)
 19   FORMAT(2X,I3,6X,F9.3,3X,F9.3,5X,F9.3,5X,F9.3,12X,F9.3,4X,F9.3,7X,
     1 F8.3,4X,F8.3)
 20   CONTINUE
C
C WRITE THE PARTITION TEMPERATURE AND HEAT FLUX DATA
C
      WRITE(6,21)
 21   FORMAT(3X,5HPARTN)
C
      DO 23 IP = 1,2
C
C CONVERT PARTITION SURFACE TEMPERATURES TO FAHRENHEIT
C
      FTSP(IP,2,ICMP) = TSP(IP,2,ICMP) - T460
      FTSP(IP,1,ICMP) = TSP(IP,1,ICMP) - T460
      IX = IP + 20
      WRITE(6,22) IP, ASRFUZ(IX,ICMP), ASRFLZ(IX,ICMP), CVFLWU(IX,ICMP),
     1                CVFLWL(IX,ICMP), RDFLWU(IX,ICMP), RDFLWL(IX,ICMP),
     2                FTSP(IP,2,ICMP), FTSP(IP,1,ICMP)
 22   FORMAT(4X,I1,6X,F9.3,3X,F9.3,5X,F9.3,5X,F9.3,12X,F9.3,4X,F9.3,7X,
     1 F8.3,4X,F8.3 )
 23   CONTINUE
C
C COMPUTE THE SUMS OF THE AREAS AND FLUXES TO SURFACES AND
C  PARTITIONS AND WRITE THEM OUT
C
      SUMAU = 0.
      SUMAL = 0.
      SUMCU = 0.
      SUMCL = 0.
      SUMRU = 0.
      SUMRL = 0.
      DO 2301 ISRF = 1, LSN
      SUMAU = SUMAU + ASRFUZ(ISRF,ICMP)
      SUMAL = SUMAL + ASRFLZ(ISRF,ICMP)
      SUMCU = SUMCU + CVFLWU(ISRF,ICMP)
      SUMCL = SUMCL + CVFLWL(ISRF,ICMP)
      SUMRU = SUMRU + RDFLWU(ISRF,ICMP)
 2301 SUMRL = SUMRL + RDFLWL(ISRF,ICMP)
      SUMAU = SUMAU + ASRFUZ(21,ICMP) + ASRFUZ(22,ICMP)
      SUMAL = SUMAL + ASRFLZ(21,ICMP) + ASRFLZ(22,ICMP)
      SUMCU = SUMCU + CVFLWU(21,ICMP) + CVFLWU(22,ICMP)
```

```
      SUMCL = SUMCL + CVFLWL(21,ICMP) + CVFLWL(22,ICMP)
      SUMRU = SUMRU + RDFLWU(21,ICMP) + RDFLWU(22,ICMP)
      SUMRL = SUMRL + RDFLWL(21,ICMP) + RDFLWL(22,ICMP)
C
      WRITE(6,2302) SUMAU,SUMAL,SUMCU,SUMCL,SUMRU,SUMRL
 2302 FORMAT(/3X,5HTOTAL,3X,F9.3,3X,F9.3,5X,F9.3,5X,F9.3,12X,F9.3,
     *       4X,F9.3)
 24   CONTINUE
C
C WRITE OUT VENT FLOW DATA FOR ALL VENTS
C
      WRITE(6,25)
 25   FORMAT(/1X,52HVOLUME AND ENERGY FLOW RATES THRU VENTS  (CU FT/SEC)
     1          ,11H, (BTU/SEC) )
C
C FIRST 8 OR FEWER VENTS
C
      IS = 1
      IE = 8
      IF( NV .LT. 8 ) IE = NV
      DO 26 IV = IS , IE
      NA(IV) = CNCTNS(IV) /10.
 26   NB(IV) = CNCTNS(IV) - NA(IV) * 10
      WRITE(6,27) (IV, IV = IS, IE )
 27   FORMAT(/1X,4HVENT,8(13X,I2) )
      WRITE(6,28) (NA(IV), NB(IV), IV = IS, IE )
 28   FORMAT(1X,8HCONNECTS,6X,8(I2,4H TO ,I2,7X) )
      WRITE(6,29) (VTFLWV(IV,2), IV = IS, IE )
 29   FORMAT(1X,11HNET UPR-UPR/2X,10HVOLUME    ,8(E13.6,2X) )
      WRITE(6,30) (VTFLWE(IV,2), IV = IS, IE)
 30    FORMAT(2X,10HENERGY    ,8(E13.6,2X) )
      WRITE(6,31) (VTFLWV(IV,1), IV = IS, IE )
 31   FORMAT(1X,11HNET LWR-LWR/2X,10HVOLUME    ,8(E13.6,2X) )
      WRITE(6,32) (VTFLWE(IV,1), IV = IS, IE )
 32   FORMAT(2X,10HENERGY    ,8(E13.6,2X) )
      IF( NV  LE. 8 ) GO TO 35
C
C  VENTS 9 THRU 16
C
      IS = 9
      IE = 16
      IF( NV .LT. 16 ) IE = NV
      IX = 0
      DO 33 IV = IS, IE
      IX = IX + 1
      NA(IX) = CNCTNS(IV) / 10.
      NB(IX) = CNCTNS(IV) - NA(IX) * 10
 33   CONTINUE
      WRITE(6,27) (IV, IV = IS, IE )
      WRITE(6,28) (NA(II), NB(II), II = 1, IX)
      WRITE(6,29) (VTFLWV(IV,2),IV = IS, IE )
      WRITE(6,30) (VTFLWE(IV,2),IV = IS, IE )
      WRITE(6,31) (VTFLWV(IV,1),IV = IS,IE )
      WRITE(6,32) (VTFLWE(IV,1), IV = IS, IE )
C
      IF( NV .LE. 16 ) GO TO 35
C
C  VENTS 17 THRU 24
C
      IS = 17
      IE = 24
```

```
      IF( NV .LT. 24 ) IE = NV
      IX = 0
      DO 34 IV = IS, IE
      IX = IX + 1
      NA(IX) = CNCTNS(IV) / 10.
      NB(IX) = CNCTNS(IV) - NA(IX) * 10
 34   CONTINUE
      WRITE(6,27) (IV, IV = IS, IE )
      WRITE(6,28) (NA(II), NB(II), II = 1, IX )
      WRITE(6,29) (VTFLWV(IV,2) , IV = IS, IE )
      WRITE(6,30) (VTFLWE(IV,2), IV = IS, IE )
      WRITE(6,31) (VTFLWV(IV,1), IV = IS, IE )
      WRITE(6,32) (VTFLWE(IV,1), IV = IS, IE )
 35   CONTINUE
C
C PRINT NUMERIC SOLUTION DATA AND RESET NDXS
C
      WRITE(6,36)
 36   FORMAT(/1X,42HSOLUTION DATA - TIME STEPS IN MILLISECONDS )
      WRITE(6,37) (STATS(II,1), STATS(II,2), II = 1,NDXS )
 37   FORMAT( 6(2X,5HSTEP ,F6.0,5H ITR ,F3.0) )
      NDXS = 0
C
C IF IPR2 IS NOT = 0, FLAME SPRD DATA IS NOT TO BE WRITTEN, SO RETURN.
C
 40   IF(IPR2.NE.0)GO TO 500
C IF THERE ARE NO CURRENTLY ACTIVE FIRES, RETURN.
      IF(NFIRES.LE.0) GO TO 500
C REPORT THE NUMBER OF SMLDRG, FLAMING, AND CHARRED ELMNTS AT THE END
C OF THE LAST SET OF FLAME SPREAD CALCULATIONS.
      WRITE(6,44)
 44   FORMAT(//5X,50HELEMENT STATE SUMMARY - CONDITIONS ON ALL SURFACES,
     136H AT END OF FLAME SPREAD CALCULATIONS)
      IS=LSN+NSG
      WRITE(6,50)
 50   FORMAT(18X,114H1   2   3   4   5   6   7   8   9   10  11  12  13
     1 14  15  16  17  18  19  20  21  22  23  24  25  26  27  28  29)
      WRITE(6,51) (NPE(I),I=1,IS)
 51   FORMAT(5X,11HSMOLDERING ,30I4)
      WRITE(6,52) (NFE(I),I=1,IS)
 52   FORMAT(5X,7HFLAMING,4X,30I4)
      WRITE(6,53) (NCE(I),I=1,IS)
 53   FORMAT(5X,7HCHARRED,4X,30I4)
C REPORT THE CURRENT SURFACE AREAS SMLDRG, FLAMING, AND CHARRED BY
C MATERIAL TYPE.
      WRITE(6,65)
 65   FORMAT(//5X62H FLAMING,SMOLDERING,AND CHARRED AREAS BY MATERIAL TY
     *PE (SQ FT)/)
      WRITE(6,70)(M,M=1,NMATLS)
 70   FORMAT(5X,11HMATERIAL NO,7(8X,I2))
      WRITE(6,71)(AFM(M),M=1,NMATLS)
 71   FORMAT(5X,13HAREA AFLAME  ,7F10.2)
      WRITE(6,72)(ASM(M),M=1,NMATLS)
 72   FORMAT(5X,13HAREA SMLDRG  ,7F10.2)
      WRITE(6,73)(ACM(M),M=1,NMATLS)
 73   FORMAT(5X,13HAREA CHRRD   ,7F10.2)
C START A NEW PAGE, PRINT THE TIME AND HEADING INFORMATION.
      WRITE(6,2) TIME, (IDENT(M), M =1, 20 )
      WRITE(6,202)
 202  FORMAT(//5X,68HDISTRIBUTION OF ELEMENTAL STATES AT END OF FLAME SP
     1READ CALCULATIONS//)
```

```
      WRITE(6,203)
 203  FORMAT(//5X,49HINTEGERS CORRESPOND TO STATES OF INDIVIDUAL ELEM-//
     120X,15H1=AMBIENT STATE/20X,18H2=SMOLDERING STATE/20X,8H3=AFLAME/
     220X,9H4=CHARRED/20X,35H5=HEATING,NOT IN CONTACT WITH FLAME/20X,31H
     36=HEATING,IN CONTACT WITH FLAME/20X,20H7=SMOLDERING,COOLING//10X,3
     4HAFT)
C THE NEXT 14 STMTS PRINT THE VIEW OF THE ELEMENT STATES ON ALL THE
C CABIN LINING SURFACES.  ISURF IS A UTILITY ARRAY CONTAINING THE PICTURE
      JX=JMAX(1)
      DO 210 II=1,MAXELI
      DO 205 JJ=1,JX
      CALL CVOUT(II,JJ,1,IST,ISTP,ITFCP)
      ISURF(II,JJ)=IST
 205  CONTINUE
 210  CONTINUE
      KK=JX
      JJ=JX+1
      DO 215 J=1,KK
      JJ=JJ-1
      WRITE(6,212)(ISURF(I,JJ),I=1,MAXELI)
 212  FORMAT(10X,120I1)
 215  CONTINUE
C *** THIS NEXT PART FINDS THE DIFFERENT CABIN LINING SURFACES AND
C *** PRINTS THE ELEMENT'S SURFACE NUMBER UNDER THE PRINTED VIEW
C *** OF THE ELEMENTS STATE.
      DO 217 ISRFNO=1,LSN
      MINSN=IMIN(ISRFNO)
      MAXSN=IMAX(ISRFNO)
      ISRFN1=ISRFNO/10
      ISRFN2=ISRFNO-(ISRFN1*10)
      DO 216 IN=MINSN,MAXSN
      LNSRFN(IN)=ISRFN1
      LNSRFC(IN)=ISRFN2
 216  CONTINUE
 217  CONTINUE
      WRITE(6,218)(LNSRFN(IN),IN=1,MAXELI)
 218  FORMAT(3X,'LINING',/
     &        3X,' SURF ',1X,120I1)
      WRITE(6,219)(LNSRFC(IN),IN=1,MAXELI)
 219  FORMAT(3X,'NUMBER',1X,120I1)
C ******
C SCAN ALL SEAT GROUPS TO FIND IF THERE ARE ANY SMLDRG OR FLAMING ELMNTS
C ON ANY OF THEM.  IF NOT, RETURN.
      IX=LSN+1
      DO 220 I=IX,NS
      IF(NFE(I).NE.0 .OR. NPE(I).NE.0)GO TO 230
 220  CONTINUE
      RETURN
C START A NEW PAGE, PRINT THE TIME AND HEADING INFORMATION.
 230  WRITE(6,2) TIME, (IDENT(M), M= 1, 20 )
      WRITE(6,235)
 235  FORMAT(//10X,41HFOR SEAT GROUPS---J= 1- 4  CUSHION,BOTTOM/28X,26HJ
     1= 5- 7  BACKREST,LWR REAR/28X,26HJ= 8-11  BACKREST,UPR REAR/28X,21
     2HJ=12      BACKREST,TOP/28X,23HJ=13-18  BACKREST,FRONT/28X,20HJ=19-
     321  CUSHION,TOP/28X,22HJ=22      CUSHION,FRONT)
C IPG INDICATES WHETHER A NEW PAGE AND HEADING IS TO BE PRINTED.
      IPG=0
C THE NEXT LOOP (THRU 300) FORMS AND PRINTS THE PICTURE OF THE ELMNTS ON
C EACH SEAT GROUP.  A SEPARATE PAGE IS USED FOR EACH GROUP AND A GROUP IS
C SKIPPED IF THERE ARE NO CURRENT FLAMING OR SMLDRG ELMNTS ON IT.
      DO 300 IS=1,NSG
```

```
      I=IS+LSN
      IF(NFE(I).EQ.0 .AND. NPE(I).EQ.0)GO TO 300
      IPG=IPG+1
      IF(IPG.LE.1)GO TO 240
      WRITE(6,10) TIME
 240  WRITE(6,245)IS
 245  FORMAT(//10X,13HSEAT GROUP NO,I2//)
      IWIDE=2.0*SGWD(IS)+TOL
      JJ=23
      WRITE(6,261)
      DO 275 J=1,22
      JJ=JJ-1
      DO 250 II=1,IWIDE
      CALL CVOUT(II,JJ,I,IST,ISTP,ITFCP)
      ISSURF(II)=IST
 250  CONTINUE
      WRITE(6,260)JJ,(ISSURF(II),II=1,IWIDE)
 260  FORMAT(22X,I2,2X,40I1)
      IF(LNUNDR(J))WRITE(6,261)
 261  FORMAT(1H+,2X,19H___________________)
      IF(NWRD(J).NE.0)WRITE(6,262)(IGRPDF(NWRD(J),K),K=1,5)
 262  FORMAT(1H+,1X,5A4)
 275  CONTINUE
 300  CONTINUE
C
 500  RETURN
      END
```

```
      SUBROUTINE RDCNTL
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1             IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2             RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3             TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4             ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5             FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6             IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7             IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8             JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9             NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1             RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2             TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3             FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4             TP(7),TPC(7)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1             RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2             VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DGI,DGM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5             XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6             WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
      INTEGER ECOFLG
C
C READ 80 CHARACTERS OF RUN IDENTIFICATION - CARD TYPE 1
C
      READ(5,1) (IDENT(M),M=1,20)
 1    FORMAT(20A4)
C
C READ CARD TYPE 2, PROGRAM TIME CONTROL DATA
C
      READ(5,2) DELTAT,TFINAL,EPSLN,MAXITR,MAXCUT,JCBSKP,IRATIO,ISCALE
 2    FORMAT(3F10.1,5I5)
C
C READ CARD TYPE 3, OUTPUT CONTROL DATA
C
      READ(5,3) IPEMS, IPSPR, IPAUX, ECOFLG
 3    FORMAT(4I5)
C
```

```
RETURN
END
```

AD-A118 390 DAYTON UNIV OH RESEARCH INST F/G 1/2
DAYTON AIRCRAFT CABIN FIRE MODEL, VERSION 3. VOLUME II. PROGRAM--ETC(U)
JUN 82 C D MACARTHUR DOT-FA74WA-3532
UNCLASSIFIED UDRI-TR-81-160-VOL-2 DOT/FAA/CT-81/69-2 NL

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118390

```
      SUBROUTINE AUXOUT
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RQS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
C ----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) WRITES FORMATTED VALUES OF CERTAIN CABIN GAS VARIABLES TO UNIT 8
C     (DISK OR TAPE AS DEFINED BY USER'S JCL) FOR LATER PLOTTING OR
C     OTHER USES.
C COMMENTS
C (1)
C ----------------------------------------------------------------------
      COMMON /PRTCMN/ ASRFUZ(22, 4), ASRFLZ(22, 4), CVFLWU(22, 4),
     *                CVFLWL(22, 4), RDFLWU(22, 4), RDFLWL(22, 4),
     *                VTFLWV(24, 2), VTFLWE(24, 2),  FBVDOT(30),
     *                FBSDOT(11, 30), FBGDOT(30), FRENTR(30)
      DIMENSION IO(12), IDATA(7), IND1(10), IND2(10), IND3(10), CONC(10),
     1          IZN(2), ISURF(120, 15), ISSURF(40), FTU(5), FTL(5), XPF(5)
      DIMENSION LNSRFN(120), LNSRFC(120), STATS(50, 2), PPMU(10), PPML(10)
      DIMENSION NWRD(22), IGRPDF(7, 5), NA(8), NB(8), FTSL(20, 2, 4),
```

```
     1           FTSP(2,2,4),SMKU(5),SMKL(5)
C
C CONVERT TIME TO SECONDS
C
      TIME=ITIME/THOU
C
C WRITE TIME AND RUN ID
C
      WRITE(8,2) TIME, (IDENT(M),M=1,20)
 2    FORMAT(F9.3,20A4)
C
      DO 24 ICMP=1,NCOMPS
C CONVERT GAS TEMPERATURES TO FAHRENHEIT
C
      FTU(ICMP) = TU(ICMP) - T460
      FTL(ICMP) = TL(ICMP) - T460
C
C CONVERT PRESSURE TO LBF/SQ FT AND SMOKE TO OD/FT
C
      XPF(ICMP) = PF(ICMP) / GRAV
      SMKU(ICMP) = 0.0457575 * CHIU(NSPCS,ICMP) * RHOU(ICMP)
      SMKL(ICMP) = 0.0457575 * CHIL(NSPCS,ICMP) * RHOL(ICMP)
C
      XX = CH - ZD(ICMP)
      WRITE(8,4) ICMP, XX, VOLU(ICMP), FTU(ICMP), RHOU(ICMP),
     1    SMKU(ICMP)  , CHIU(2,ICMP), CHIU(4,ICMP), CHIU(5,ICMP),
     2 XPF(ICMP), ZD(ICMP), VOLL(ICMP), FTL(ICMP), RHOL(ICMP),
     3    SMKL(ICMP)  , CHIL(2,ICMP), CHIL(4,ICMP), CHIL(5,ICMP)
 4    FORMAT(I1,F8.3,F8.1,F8.2,F8.5,
     1 F7.3,3F8.5,F8.2,F8.3,
     2 F8.1,F8.2,F8.5,F7.3,3F8.5)
C
      IXS = NSPCS - 1
      WRITE(8,5) (NGAS(IG),IG=1,IXS)
 5    FORMAT(10A4)
C
C CONVERT   GAS CONCENTRATIONS FROM MASS FRACTION TO PPM BY VOLUME
C
      SUML = 0.
      SUMU = 0.
C
      DO 6 IG=1,IXS
      SUML = SUML + CHIL(IG,ICMP) / WMOLEC(IG)
 6    SUMU = SUMU + CHIU(IG,ICMP) / WMOLEC(IG)
C
      DO 7 IG=1,IXS
      PPML(IG) = 0.
      PPMU(IG) = 0.
      IF(SUML .GT.  0.) PPML(IG) = CHIL(IG,ICMP)/(SUML * WMOLEC(IG))
      IF(SUMU .GT.  0.) PPMU(IG) = CHIU(IG,ICMP)/(SUMU * WMOLEC(IG))
      PPML(IG) = PPML(IG) * 1.E+6
 7    PPMU(IG) = PPMU(IG) * 1.E+6
C
      WRITE(8,8) (PPMU(IG),IG=1,IXS)
 8    FORMAT(10F9.0)
      WRITE(8,9) (PPML(IG),IG=1,IXS)
 9    FORMAT(10F9.0 )
C
C IF THIS IS THE COMPARTMENT WITH INTERIOR FIRES PRINT THE FIRE DATA
C
      IF( ICMP .NE. IFRCMP ) GO TO 17
```

```
      IF( NFIRES .EQ. 0 ) GO TO 17
C
      DO 12 N=1,NFIRES
      IXS = NTXG + 6
      WRITE(8,11) N, AF(N), FBVDOT(N), FBGDOT(N), FRENTR(N), FLML(N),
     1              ABSCF(N), FBSDOT(IXS,N), FBSDOT(2,N)
 11   FORMAT(I3,F8.2,3E13.6,F8.2,3E13.6)
 12   CONTINUE
C
C
      IXS = 5 + NTXG
      WRITE(8,14) (NGAS(IG), IG = 6, IXS )
 14   FORMAT(5A4)
C
      DO 16 N = 1, NFIRES
      WRITE(8,15) N, (FBSDOT(IG,N),IG = 6,IXS )
 15   FORMAT(I3,5E13.6)
 16   CONTINUE
C
 17   CONTINUE
C
C WRITE THE SURFACE TEMPERATURE AND HEAT FLUX DATA
C
C
      DO 20 ISRF = 1, LSN
C
C CONVERT LINING SURFACE TEMPERATURES TO FAHRENHEIT
C
      FTSL(ISRF,2,ICMP) = TSL(ISRF,2,ICMP) - T460
      FTSL(ISRF,1,ICMP) = TSL(ISRF,1,ICMP) - T460
      WRITE(8,19) ISRF, ASRFUZ(ISRF,ICMP), ASRFLZ(ISRF,ICMP),
     1                  CVFLWU(ISRF,ICMP), CVFLWL(ISRF,ICMP),
     2                  RDFLWU(ISRF,ICMP), RDFLWL(ISRF,ICMP),
     3                  FTSL(ISRF,2,ICMP), FTSL(ISRF,1,ICMP)
 19   FORMAT(I3,6F9.3,2F8.3)
 20   CONTINUE
C
C WRITE THE PARTITION TEMPERATURE AND HEAT FLUX DATA
C
C
      DO 23 IP = 1,2
C
C CONVERT PARTITION SURFACE TEMPERATURES TO FAHRENHEIT
C
      FTSP(IP,2,ICMP) = TSP(IP,2,ICMP) - T460
      FTSP(IP,1,ICMP) = TSP(IP,1,ICMP) - T460
      IX = IP + 20
      WRITE(8,22) IP, ASRFUZ(IX,ICMP), ASRFLZ(IX,ICMP), CVFLWU(IX,ICMP),
     1              CVFLWL(IX,ICMP), RDFLWU(IX,ICMP), RDFLWL(IX,ICMP),
     2              FTSP(IP,2,ICMP), FTSP(IP,1,ICMP)
 22   FORMAT(I1,6F9.3,2F8.3)
 23   CONTINUE
C
C COMPUTE THE SUMS OF THE AREAS AND FLUXES TO SURFACES AND
C  PARTITIONS AND WRITE THEM OUT
C
      SUMAU = 0.
      SUMAL = 0.
      SUMCU = 0.
      SUMCL = 0.
      SUMRU = 0.
```

```
      SUMRL = 0.
      DO 2301 ISRF = 1, LSN
      SUMAU = SUMAU + ASRFUZ(ISRF,ICMP)
      SUMAL = SUMAL + ASRFLZ(ISRF,ICMP)
      SUMCU = SUMCU + CVFLWU(ISRF,ICMP)
      SUMCL = SUMCL + CVFLWL(ISRF,ICMP)
      SUMRU = SUMRU + RDFLWU(ISRF,ICMP)
 2301 SUMRL = SUMRL + RDFLWL(ISRF,ICMP)
      SUMAU = SUMAU + ASRFUZ(21,ICMP) + ASRFUZ(22,ICMP)
      SUMAL = SUMAL + ASRFLZ(21,ICMP) + ASRFLZ(22,ICMP)
      SUMCU = SUMCU + CVFLWU(21,ICMP) + CVFLWU(22,ICMP)
      SUMCL = SUMCL + CVFLWL(21,ICMP) + CVFLWL(22,ICMP)
      SUMRU = SUMRU + RDFLWU(21,ICMP) + RDFLWU(22,ICMP)
      SUMRL = SUMRL + RDFLWL(21,ICMP) + RDFLWL(22,ICMP)
C
      WRITE(8,2302) SUMAU,SUMAL,SUMCU,SUMCL,SUMRU,SUMRL
 2302 FORMAT(6F9.3)
 24   CONTINUE
C
C WRITE OUT VENT FLOW DATA FOR ALL VENTS
C
C
C FIRST 8 OR FEWER VENTS
C
      IS = 1
      IE = 8
      IF( NV .LT. 8 ) IE = NV
      DO 26 IV = IS , IE
      NA(IV) = CNCTNS(IV) /10.
 26   NB(IV) = CNCTNS(IV) - NA(IV) * 10
      WRITE(8,27) (IV, IV = IS, IE )
 27   FORMAT(8I2)
      WRITE(8,28) (NA(IV), NB(IV), IV = IS, IE )
 28   FORMAT(8(I2,I2))
      WRITE(8,29) (VTFLWV(IV,2), IV = IS, IE )
 29   FORMAT(8E13.6)
      WRITE(8,30) (VTFLWE(IV,2), IV = IS, IE)
 30   FORMAT(8E13.6)
      WRITE(8,31) (VTFLWV(IV,1), IV = IS, IE )
 31   FORMAT(8E13.6)
      WRITE(8,32) (VTFLWE(IV,1), IV = IS, IE )
 32   FORMAT(8E13.6)
      IF( NV .LE. 8 ) GO TO 35
C
C  VENTS 9 THRU 16
C
      IS = 9
      IE = 16
      IF( NV .LT. 16 ) IE = NV
      IX = 0
      DO 33 IV = IS, IE
      IX = IX + 1
      NA(IX) = CNCTNS(IV) / 10.
      NB(IX) = CNCTNS(IV) - NA(IX) * 10
 33   CONTINUE
      WRITE(8,27) (IV, IV = IS, IE )
      WRITE(8,28) (NA(II), NB(II), II = 1, IX)
      WRITE(8,29) (VTFLWV(IV,2),IV = IS, IE )
      WRITE(8,30) (VTFLWE(IV,2),IV = IS, IE )
      WRITE(8,31) (VTFLWV(IV,1),IV = IS,IE )
      WRITE(8,32) (VTFLWE(IV,1), IV = IS, IE )
```

```
C
      IF( NV .LE. 16 ) GO TO 35
C
C  VENTS 17 THRU 24
C
      IS = 17
      IE = 24
      IF( NV .LT. 24 ) IE = NV
      IX = 0
      DO 34 IV = IS, IE
      IX = IX + 1
      NA(IX) = CNCTNS(IV) / 10.
      NB(IX) = CNCTNS(IV) - NA(IX) * 10
 34   CONTINUE
      WRITE(8,27) (IV, IV = IS, IE )
      WRITE(8,28) (NA(II), NB(II), II = 1, IX )
      WRITE(8,29) (VTFLWV(IV,2) , IV = IS, IE )
      WRITE(8,30) (VTFLWE(IV,2), IV = IS, IE )
      WRITE(8,31) (VTFLWV(IV,1), IV = IS, IE )
      WRITE(8,32) (VTFLWE(IV,1), IV = IS, IE )
 35   CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE ATMOS(STATS,NDXS)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1               IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2               CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3               ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4               ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5               ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6               IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7               SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8               XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9               HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1               CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2               FHMIN
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1               RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2               VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3               JCOR(120)
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1               IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2               ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3               JCBSKP
      DIMENSION X(120),DUMX(120),XNEXT(120),STATS(50,2)
C
C SAVE THE VALUES OF THE CURRENT TIME AND THE NEXT TIME POINT, AS CALLED
C FOR BY DACFIR.
C  LTIME = LOCAL TIME WITHIN THIS SUBROUTINE (MILLISECONDS)
C  LDT   = LOCAL TIME INCREMENT (MILLISECONDS)
C  LTOBJ = LOCAL TIME VALUE OF THE NEXT TIME POINT (MILLISECONDS)
C  LDTPRV= PREVIOUS VALUE OF LDT
C
      LTIME = ITIME
      LDT   = IDELT
      LTOBJ = ITIME + IDELT
      LDTPRV= IDTPRV
C
C INITIALIZE TWO COUNTERS
C  INCR  = COUNTS THE NUMBER OF SUCCESSFUL SOLUTIONS OBTAINED AT THE
C          CURRENT LOCAL TIME INCREMENT WHEN INCREMENT CUTTING IN EFFECT
C  ICUT  = CURRENT CUT LEVEL.  ICUT=0 => LDT=IDELT,  ICUT=1 => LDT=IDELT/2
C          ICUT=2 => LDT=IDELT/4,  ICUT=3 => LDT=IDELT/8.
C
      INCR = 0
      ICUT = 0
      NDXS = NDXS + 1
      STATS(NDXS,1) = LDT
      STATS(NDXS,2) = 0
C
C SET THE INITIAL VALUE OF THE GAS STATE VECTOR <X>
C
 5    I = 0
      DO 30 N2 = 1, NCOMPS
      DO 10 N1 = 1, NSPCS
      I = I + 1
 10   X(I) = CHIL(N1,N2)
      DO 20 N1 = 1, NSPCS
      I = I + 1
 20   X(I) = CHIU(N1,N2)
      X(I+1) = PF(N2)
      X(I+2) = RHOL(N2)
      X(I+3) = RHOU(N2)
      X(I+4) = TL(N2)
```

```
      X(I+5) = TU(N2)
      X(I+6) = VOLL(N2)
      X(I+7) = VOLU(N2)
      X(I+8) = ZD(N2)
      I = I + 8
 30   CONTINUE
C
C SUBROUTINE SCALE SCALES THE MAGNITUDE OF THE VARIABLES TO O(1) FOR
C  IMPROVED NUMERIC SOLUTION
C
      CALL SCALE(-1,X,I)
C
C SUBROUTINE ESET1 INITIALIZES THE TERMS IN THE GAS DYNAMICS EQUATION SET
C  TO BE EVALUATED AT TIME = LTIME
C
      CALL ESET1( X, DUMX, I, LDT )
C
C SUBROUTINE EXTRAP GENERATES THE INITIAL GUESS SOLUTION FOR THE  NEXT
C  TIME POINT
C
      CALL SCALE(-1, XTHEN, I )
C
      CALL EXTRAP(XTHEN,X,XNEXT,I,LDT,LDTPRV)
C
C SUBROUTINE NWTRAP CORRECTS THE INITIAL GUESS OF THE SOLUTION BY THE
C  NEWTON-RAPHSON METHOD.  ICON IS A FLAG TO INDICATE CONVERGENCE.
C  ICON=1 => CONVERGENCE.  ITR IS THE NUMBER OF ITERATIONS MADE.
C
      CALL NWTRAP(XNEXT,I,LDT,ICON,ITR)
C
C IF CONVERGENCE WAS NOT ACHIEVED JUMP TO STMT 70 TO CUT THE TIME STEP.
C IF THE SOLUTION CONVERGED UPDATE THE LOCAL TIME AND THE VARIABLES <X>
C
      IF( ICON .EQ. 0) GO TO 70
C
      LTIME = LTIME + LDT
C
C SCALE UP TO PHYSICAL MAGNITUDES
C
      CALL SCALE(+1,XNEXT,I)
      CALL SCALE(+1,X,I)
C
C CHECK TO SEE IF IT IS TIME TO RECOMPUTE THE SCALE FACTORS
C
      LSC = MOD(LTIME,ISCALE)
      IF( LSC .EQ. 0. ) CALL SCALE( 0, XNEXT, I )
C
      I = 0
C
      DO 60 N2 = 1, NCOMPS
      DO 40 N1 = 1, NSPCS
      I = I + 1
      CHIL(N1,N2) = XNEXT(I)
 40   XTHEN(I) = X(I)
      DO 50 N1 = 1, NSPCS
      I = I + 1
      CHIU(N1,N2) = XNEXT(I)
 50   XTHEN(I) = X(I)
      PF(N2)     = XNEXT(I+1)
      XTHEN(I+1)= X(I+1)
      RHOL(N2)   = XNEXT(I+2)
```

```
      XTHEN(I+2)= X(I+2)
      RHOU(N2)   = XNEXT(I+3)
      XTHEN(I+3)= X(I+3)
      TL(N2)     = XNEXT(I+4)
      XTHEN(I+4)= X(I+4)
      TU(N2)     = XNEXT(I+5)
      XTHEN(I+5)= X(I+5)
      VOLL(N2)   = XNEXT(I+6)
      XTHEN(I+6)= X(I+6)
      VOLU(N2)   = XNEXT(I+7)
      XTHEN(I+7)= X(I+7)
      ZD(N2)     = XNEXT(I+8)
      XTHEN(I+8)= X(I+8)
      I = I + 8
 60   CONTINUE
C
      LDTPRV = LDT
      STATS(NDXS,1) = LDT
      STATS(NDXS,2) = ITR
C
C TEST TO SEE IF THE NEW LOCAL TIME IS THE OBJECTIVE FOR THIS CALL, IF
C  SO RETURN
C
      IF(LTIME .GE. LTOBJ) RETURN
C
C MORE LOCAL STEPS ARE NECESSARY TO ACHIEVE THE OBJECTIVE.  INCREMENT
C  INCR TO COUNT SUCCESSFUL INTERMEDIATE STEPS AND IF TWO HAVE BEEN MADE
C  TRY DOUBLING THE LOCAL TIME STEP.
C
      INCR = INCR + 1
      NDXS = NDXS + 1
      IF(INCR .LT. 2) GO TO 5
      LDUM = LTIME + 2 * LDT
      IF(LDUM .GT. LTOBJ) GO TO 5
      LDT = 2 * LDT
      INCR = 0
      ICUT = ICUT - 1
      GO TO 5
C
C CONVERGENCE WAS NOT ACHIEVED FOR THIS LOCAL TIME STEP, TRY AGAIN
C  WITH LDT OF ONE HALF THE CURRENT VALUE (ROUNDED TO THE NEXT
C  HIGHEST INTEGER.) IF THE CURRENT CUT LEVEL IS THE MAXIMUN
C  ALLOWED STOP THE RUN WITH AN ERROR MSG.
C
 70   IF( ICUT .EQ. MAXCUT ) GO TO 80
      LDT = FLOAT(LDT) / 2. + 0.5
      ICUT = ICUT + 1
      INCR = 0
      CALL SCALE(+1, XTHEN, I )
      GO TO 5
C
 80   WRITE(6,101) LTIME, LDT, (X(J), J=1,I),(XTHEN(J),J=1,I)
 101  FORMAT(1H1,//2X,28HCONVERGENCE FAILURE IN ATMOS//2X,7HLTIME= ,I10,
     *        5HLDT= ,I6//(2X,8E15.7))
      STOP
      END
```

```
      SUBROUTINE EXTRAP(X1, X2, X3, N, LDT, LDTP)
C-----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) THIS SUBROUTINE LINEARLY EXTRAPOLATES VALUES FROM THE ARRAYS X1
C     AND X2 TO THE CORRESPONDING ELEMENTS IN ARRAY X3
C COMMENTS
C (1) ARRAY X1 IS LDTP TIME UNITS PREVIOUS TO X2 AND X3 IS LDT UNITS
C     AHEAD
C
C-----------------------------------------------------------------------
      DIMENSION X1(120), X2(120), X3(120)
      DT = LDT
      DTP = LDTP
      C1 = DT/DTP
      C2 = 1. + C1
      DO 10 J=1,N
 10   X3(J) = X2(J) * C2 - C1 * X1(J)
      RETURN
      END
```

```
      SUBROUTINE NWTRAP(X,N,LDT,ICON,ITR)
      COMMON/NEWTON/XJCB(120,120),UL(120,120),IPS(120)
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      DIMENSION X(120),XNEW(120),F(120),H(120)
C
      DH = 0.0001
      ICON = 0
      ITR = 0
 10   CONTINUE
      CALL ESET2(X,XNEW,N,LDT)
C
C
      FNORM = 0.
C
      DO 20 I=1,N
      F(I) = XNEW(I) - X(I)
      IF( ABS( F(I) )  .LE.  FNORM ) GO TO 20
      FNORM = ABS( F(I) )
 20   CONTINUE
C
      IF( (FNORM .GT.  1.  .AND.  ITR .GT.  0) .OR.  ITR .GT.  MAXITR) RETURN
      IF( FNORM .GT.  EPSLN ) GO TO 25
      ICON = 1
      DO 22 I=1,N
 22   X(I) = XNEW(I)
      RETURN
 25   CONTINUE
C
      IF( ITR .EQ.  0) GO TO 27
      IF( MOD(ITR,JCBSKP) .NE.  0 ) GO TO 50
C
 27   CONTINUE
      DO 40 J=1,N
      SAVE = X(J)
      X(J) = SAVE + DH
      CALL ESET2(X,XNEW,N,LDT)
      DO 30 I=1,N
 30   XJCB(I,J) = (XNEW(I) - X(I) - F(I) ) / DH
      X(J) = SAVE
 40   CONTINUE
C
 50   CONTINUE
C
      CALL MSLV( H,  F,  N )
C
      DO 60 I=1,N
 60   X(I) = X(I) - H(I)
      ITR = ITR + 1
      GO TO 10
C
      END
```

```
      SUBROUTINE MSLV(X,B,N)
      COMMON /NEWTON/XJCB(120,120),UL(120,120),IPS(120)
      DIMENSION X(120),B(120)
      DO 3 I=1,N
      IF(XJCB(I,I) .NE. 0.) GO TO 3
      XJCB(I,I) = -1.
    3 CONTINUE
      CALL DECOMP(N)
      CALL SOLVE(N,B,X)
      RETURN
      END
```

```
      SUBROUTINE DECOMP(NN)
C
C DECOMPOSES MATRIX A INTO A PRODUCT OF A LOWER-DIAGONAL MATRIX
C  L WITH UNIT DIAGONAL ENTRIES AND AN UPPER-DIAGONAL MATRIX U.
C  THE OUTPUT MATRICES L AND U ARE BOTH STORED IN UL.
C
      DIMENSION SCALES(120)
      COMMON/NEWTON/A(120,120),UL(120,120),IPS(120)
      N=NN
C
C INITIALIZE IPS,UL AND SCALES
C
      DO 5 I=1,N
      IPS(I)=I
      ROWNRM = 0.0
C
      DO 2 J=1,N
      UL(I,J) = A(I,J)
      IF (ROWNRM.LT.ABS(UL(I,J))) ROWNRM = ABS(UL(I,J))
 2    CONTINUE
C
      IF (ROWNRM.EQ.0.) GO TO 4
      SCALES(I) = 1./ROWNRM
      GO TO 5
 4    WRITE(6,101)
 101  FORMAT(2X,'MATRIX WITH ZERO ROW IN DECOMP')
      SCALES(I)=0.0
 5    CONTINUE
C
C GAUSSIAN ELIMINATION WITH PARTIAL  PIVOTING
C
      NM1=N-1
      IF(NM1.LT.1) GO TO 18
C
      DO 17 K=1,NM1
      BIG=0.0
C
      DO 11 I=K,N
      IP=IPS(I)
      SIZE=ABS(UL(IP,K))*SCALES(IP)
      IF(SIZE.LE.BIG) GO TO 11
      BIG=SIZE
      IDXPIV=I
 11   CONTINUE
C
      IF (BIG.NE.0.)GO TO 13
 12   WRITE(6,102)
 102  FORMAT(2X,'SINGULAR MATRIX IN DECOMP').
      STOP
C
 13   IF(IDXPIV.EQ.K)GO TO 15
      J=IPS(K)
      IPS(K)=IPS(IDXPIV)
      IPS(IDXPIV)=J
C
 15   KP=IPS(K)
      PIVOT=UL(KP,K)
      KP1=K+1
      DO 16 I=KP1,N
      IP=IPS(I)
      EM=-UL(IP,K)/PIVOT
```

```
      UL(IP,K)=-EM
      DO 16 J=KP1,N
      UL(IP,J)=UL(IP,J)+EM*UL(KP,J)
   16 CONTINUE
   17 CONTINUE
C
   18 CONTINUE
      KP=IPS(N)
      IF(UL(KP,N).EQ.0.)GO TO 12
      RETURN
      END
```

```
      SUBROUTINE SOLVE(NN,B,X)
C
C SOLVES THE MATRIX EQUATION A*X=B FOR VECTOR X, WHERE A IS THE PRODUCT
C  OF THE LOWER- AND  UPPER-DIAGONAL FACTORS STORED IN MATRIX UL.
C
      DIMENSION B(120),X(120)
      COMMON/NEWTON/A(120,120),UL(120,120),IPS(120)
      N=NN
      NP1=N+1
C
      IP=IPS(1)
      X(1)=B(IP)
      IF(N.LT.2) GO TO 6
C
      DO 2 I=2,N
      IP=IPS(I)
      IM1=I-1
      SUM=0.
      DO 1 J=1,IM1
    1 SUM=SUM+UL(IP,J)*X(J)
    2 X(I)=B(IP)-SUM
C
    6 CONTINUE
      IP=IPS(N)
      X(N)=X(N)/UL(IP,N)
      IF(N.LT.2)GO TO 5
C
      DO 4 IBACK=2,N
      I=NP1-IBACK
      IP=IPS(I)
      IP1=I+1
      SUM=0.
      DO 3 J=IP1,N
    3 SUM=SUM+UL(IP,J)*X(J)
    4 X(I)=(X(I)-SUM)/UL(IP,I)
C
    5 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SCALE(ISW, X, M)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1             RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2             VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3             JCOR(120)
      DATA ALOG2/0.6931472/
      DIMENSION X(120)
      GO TO (1,20,10), ISW+2
C
C SCALE DOWN FROM PHYSICAL MAGNITUDES TO SCALED MAGNITUDES (ISW = -1)
C
 1    DO 5 I=1,M
      II = JCOR(I)
 5    X(I) = X(I) / TWO(II)
      RETURN
C
C SCALE UP TO PHYSICAL MAGNITUDES FROM SCALED MAGNITUDES (ISW = +1)
C
 10   DO 15 I=1,M
      II = JCOR(I)
 15   X(I) = X(I) * TWO(II)
      RETURN
C
C RESET SCALE FACTORS AND JCOR ARRAY. {X} INPUT IN PHYSICAL MAGNITUDES.
C  (ISW = 0)
C
 20   CONTINUE
      DO 30 I=1,M
      TMP = ABS(X(I))
      KEXP = 0
      IF( TMP .NE. 0. )  KEXP = ALOG(TMP)/ALOG2 + 0.5
      IF(JIABS( KEXP ) .GT. 50 ) KEXP = JISIGN( 50, KEXP )
      JCOR(I) = KEXP + 51
 30   CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE VENT(IV,PFI,PFJ,ZDI,ZDJ,RUI,RUJ,RLI,RLJ,
     *                GUIJ,GUJI,GLIJ,GLJI)
C
C ----------------------------------------------------------------------
C OBJECTIVE:
C (1) SUBROUTINE VENT COMPUTES THE RATES OF MASS FLOW THRU A SINGLE
C     VENT BETWEEN COMPARTMENTS I AND J.  FOUR NET MASS FLOW RATES
C     CAN OCCUR (ALL UNITS ARE LBM/SEC):
C
C     GUIJ = FLOW RATE FROM THE UPPER ZONE OF COMPARTMENT I TO THAT OF J
C
C     GUJI = FLOW RATE FROM THE UPPER ZONE OF COMPARTMENT J TO THAT OF I
C
C     GLIJ = FLOW RATE FROM THE LOWER ZONE OF COMPARTMENT I TO THAT OF J
C
C     GLJI = FLOW RATE FROM THE LOWER ZONE OF COMPARTMENT J TO THAT OF I
C
C     THE FOLLOWING QUANTITIES ARE GIVEN IN THE CALL:
C
C     IV  = VENT ID NUMBER
C
C     PFI = PRESSURE (LBM/(FT*SEC**2)) AT FLOOR OF COMPARTMENT I
C
C     PFJ = PRESSURE (LBM/(FT*SEC**2)) AT FLOOR OF COMPARTMENT J
C
C     ZDI = THERMAL DISCONTINUITY POSITION (FT) IN COMPARTMENT I
C
C     ZDJ = THERMAL DISCONTINUITY POSITION (FT) IN COMPARTMENT J
C
C     RUI = DENSITY OF UPPER ZONE GAS (LBM/FT**3) IN COMPARTMENT I
C
C     RUJ = DENSITY OF UPPER ZONE GAS (LBM/FT**3) IN COMPARTMENT J
C
C     RLI = DENSITY OF LOWER ZONE GAS (LBM/FT**3) IN COMPARTMENT I
C
C     RLJ = DENSITY OF LOWER ZONE GAS (LBM/FT**3) IN COMPARTMENT J
C
C COMMENTS:
C (1) THE VENT ID NUMBER INDEXES THE VENT GEOMETRY THRU COMMON /GMTRY/
C
C (2) FLOOR LEVELS IN EACH COMPARTMENT ARE ASSUMED EQUAL
C
C (3) UPPER ZONE GASES FLOW ONLY TO THE OPPOSITE UPPER ZONES AND LOWER
C     ZONE GASES FLOW ONLY TO THE OPPOSITE LOWER ZONES.
C ----------------------------------------------------------------------
C
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1              IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),BSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/PARAMS/GRAV,PI,GTR,RGAS,SIGMA,SGD,THOU,TOL,EC,EP
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
```

```
     2              ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3              JCBSKP
      DIMENSION ZL(7), ZN(4), ZX(7), DP(7), RO(7)
      DATA ORFC/0.68/
C
C INITIALIZE THE ARRAY OF NEUTRAL PLANE POSITIONS, ZN, AND COMPUTE THE
C  FLOOR PRESSURE AND ZONE DENSITY DIFFERENCES.
C
      QUIJ = 0.
      QLIJ = 0.
      QUJI = 0.
      QLJI = 0.
      DO 5 I=1,4
    5 ZN(I) = -99.
      DPF = PFI - PFJ
      DRLL = RLI - RLJ
      DRLU = RLI - RUJ
      DRUL = RUI - RLJ
      DRUU = RUI - RUJ
C
C COMPUTE THE POSITIONS OF ALL POSSIBLE NEUTRAL PLANES BETWEEN I AND J
C
      XX = DPF / GRAV
      IF(DRLL .NE. 0.) ZN(1) = XX / DRLL
      IF(DRUL .NE. 0.) ZN(2) = (XX + ZDI * (RUI - RLI) ) / DRUL
      IF(DRLU .NE. 0.) ZN(3) = (XX + ZDJ * (RLJ - RUJ) ) / DRLU
      IF(DRUU .NE. 0.) ZN(4) = (XX + ZDI * (RUI - RLI) ) / DRUU
C
C ELIMINATE THE PHYSICALLY IMPOSSIBLE NEUTRAL PLANES
C
      IF( ZN(1) .GT. ZDI ) ZN(1) = -99.
      IF( ZN(2) .LT. ZDI ) ZN(2) = -99.
      IF( ZN(3) .LT. ZDJ ) ZN(3) = -99.
      IF( ZN(4) .LT. ZDI ) ZN(4) = -99.
C
C FIND THE UPPER, ZVU, AND LOWER, ZVL, LIMITS OF THIS VENT (FT)
C
      ZVU = VENTT(IV)
      ZVL = VENTT(IV) - VENTH(IV)
      ZL(1) = ZVL
C
C LOAD THE LIST ZX WITH ANY EXISTING NEUTRAL PLANE BETWEEN ZVL AND ZVU
C
      IC = 1
C
      DO 10 II=2,5
      XX = ZN(II-1)
      IF( (XX .LT. ZVL) .OR. (XX .GT. ZVU) ) GO TO 10
      IC = II
      ZX(II) = XX
   10 CONTINUE
C
C ADD ZDI AND/OR ZDJ TO THE LIST ZX IF THEY ARE IN THE VENT OPENING
C
      IF( (ZDI .LE. ZVL) .OR. (ZDI .GE. ZVU) ) GO TO 20
      IC = IC + 1
      ZX(IC) = ZDI
   20 IF( (ZDJ .LE. ZVL) .OR. (ZDJ .GE. ZVU) ) GO TO 30
      IC = IC + 1
      ZX(IC) = ZDJ
   30 CONTINUE
```

```
      IC = IC + 1
      ZL(IC) = ZVU
C
C SORT THE LIST ZX INTO THE LIST ZL
C
      IF( IC .LT. 4 ) GO TO 60
      DO 50 IK=2, IC-1
      JJ=2
      ZL(IK) = ZX(2)
      DO 40 IL=3, IC-1
      IF( ZL(IK) .LT. ZX(IL) ) GO TO 40
      ZL(IK) = ZX(IL)
      JJ = IL
 40   CONTINUE
      ZX(JJ) = ZVU + 1.
 50   CONTINUE
 60   IF( IC .EQ. 3 ) ZL(2) = ZX(2)
C
C COMPUTE THE PRESSURE DIFFERENCE BETWEEN COMPARTMENTS AT EACH ZL
C  NOTE THAT DP > 0 => PRI > PRJ
C
      DO 70 K=1, IC
      PRI = PFI - RLI * GRAV * ZL(K)
      IF(ZL(K) .GT. ZDI) PRI = PFI + GRAV*(ZDI* (RUI-RLI) - RUI*ZL(K))
      PRJ = PFJ - RLJ * GRAV * ZL(K)
      IF(ZL(K) .GT. ZDJ) PRJ = PFJ + GRAV*(ZDJ* (RUJ-RLJ) - RUJ*ZL(K))
      DP(K) = PRI - PRJ
 70   CONTINUE
C
C BASED ON THE SIGN OF DP AT EACH LEVEL SELECT THE DENSITY OF THE
C  FLOWING GAS
C
      DO 90 K=2, IC
      IF( (DP(K) .GT. 0. ) .OR. (DP(K-1) .GT. 0. ) ) GO TO 80
      RO(K-1) = RLJ
      IF( ZL(K-1) .GT. ZDJ ) RO(K-1) = RUJ
      GO TO 90
 80   RO(K-1) = RLI
      IF( ZL(K-1) .GT. ZDI ) RO(K-1) = RUI
 90   CONTINUE
C
C BASED ON THE VALUE AND SIGN OF DP AT EACH ZL COMPUTE THE FLOW RATE
C  BETWEEN EACH PAIR OF ZL'S.  ASSIGN THE FLOW RATE TO THE PROPER OUTPUT
C  VARIABLE BASED ON ZL(K) AND ZDI, ZDJ.
C
      DO 120 K=2, IC
      IF ( ( DP(K) .EQ. 0. ) .AND. ( DP(K-1) .EQ. 0. ) ) GO TO 120
      DDP  = ABS(DP(K)) - ABS(DP(K-1))
      IF( DDP .NE. 0. ) GO TO 100
      XX = 1.414214 * ORFC * VENTW(IV) * (ZL(K) - ZL(K-1))
      XX = XX * SQRT( ABS(DP(K)) * RO(K-1) )
      GO TO 110
C
 100  AA = DDP / (ZL(K) - ZL(K-1))
      BB = 0.
      IF( DP(K) .NE. 0. ) BB = ( ABS(DP(K)) )**1.5
      CC = 0.
      IF( DP(K-1) .NE. 0. ) CC = ( ABS(DP(K-1)) )**1.5
      XX = 0.9428090 * ORFC * VENTW(IV) * SQRT( RO(K-1) ) / AA
      XX = XX * ( BB - CC )
C
```

```
 110  IF((DP(K) + DP(K-1)) .LT. 0. ) GO TO 114
      IF( ZL(K) .GT. ZDI ) GO TO 112
      GLIJ = GLIJ + XX
      GO TO 120
 112  GUIJ = GUIJ + XX
      GO TO 120
 114  IF( ZL(K) .GT. ZDJ ) GO TO 116
      GLJI = GLJI + XX
      GO TO 120
 116  GUJI = GUJI + XX
 120  CONTINUE
C
C
      RETURN
C
      END
```

```
      SUBROUTINE PLUME(ZD, RO, TT, CHI, NSPCS, IC, GPENT, CPENT, EPENT)
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1              IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2              RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3              TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4              ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5              FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6              IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7              IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8              JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9              NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1              RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2              TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3              FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4              TP(7),TPC(7)
      COMMON/PARAMS/GRAV,PI,GTR,RGAS,SIGMA,SGD,THOU,TOL,EC,EP
      COMMON /PRTCMN/ ASRFUZ(22,4),ASRFLZ(22,4),CVFLWU(22,4),
     *                 CVFLWL(22,4),RDFLWU(22,4),RDFLWL(22,4),
     *                 VTFLWV(24,2),VTFLWE(24,2),FBVDOT(30),
     *                 FBSDOT(11,30),FBGDOT(30),FRENTR(30)
      DIMENSION CHI(11,4), CPENT(11)
      DIMENSION GEP(30), CEP(11,30), EEP(30)
C
      GPENT = 0.
      EPENT = 0.
      YO2 = CHI(2,IC)
      DO 10 I=1,NSPCS
 10   CPENT(I) = 0.
C
C IF THERE ARE NO CURRENT FIRES RETURN
C
      IF( NFIRES .EQ. 0. ) RETURN
C
      DO 50 N=1,NFIRES
C
C IF THIS FIRE BASE IS IN THE UPPER ZONE, THERE WILL BE NO
C  ENTRAINMENT SO SKIP TO END OF LOOP
C
      IF( IZONE(N) .EQ. 2 ) GO TO 50
C
C INITIALIZE ENTRAINMENT RATE VARIABLES (MASS, SPECIES, AND ENERGY)
C  FOR EACH FIRE
C
      GEP(N) = 0.
      EEP(N) = 0.
      DO 20 I=1,NSPCS
 20   CEP(I,N) = 0.
      DMEC = 0.
      DMEP = 0.
C
      T1 = ( RHOZ(N) * UZ(N) / (RO * SQRT( GRAV * YZ(N) ) ) ) **0.4
      T2 = OMEGA(N) * RO / RHOZ(N) + GAMMA(N) / YO2
      ZZ = ZD - ZB(N)
      IF( ZZ .LE. 0. ) GO TO 30
C
      IF( ZZ .GT. COMB(N) ) ZZ = COMB(N)
      FR = UZ(N) * UZ(N) / ( GRAV * YZ(N) )
      T3 = AF(N) * UZ(N) * RO * OMEGA(N)
      T4 = ( ( 0.42 *( 1.0 - OMEGA(N) ) )/( EC * FR * OMEGA(N)**3))**0.2
      DMEC = T3 * ((( 0.8 * EC * T4 *( ZZ / YZ(N) ) + 1.) ** 2.5) -1.)
      IF( ZD .LT. (ZB(N) + COMB(N)) ) GO TO 30
```

```
C
      T3 = (EC / ( SQRT((1.-OMEGA(N))*OMEGA(N)**3) ) ) **0.2
      T4 = (( (1. + GAMMA(N) / YO2 )**5) / T2) ** 0.1
      YS = 1.19 * YZ(N) * T3 * T4 * T1
      T3 = ( YZ(N) / YS )**2
      T4 = 1. + ( GAMMA(N) / YO2 ) / ( OMEGA(N) * RO / RHOZ(N) )
      XMUS = UZ(N) * T3 * T4
      FS = XMUS * XMUS / ( GRAV * YS )
      RHOS = RO * OMEGA(N) * (1. + GAMMA(N) / YO2 ) / T2
      T3 = PI * YS * YS * XMUS * RO
      T4 = (0.625 / EP *(1. -( RHOS/RO )) / FS) **0.2
      ZTEMP = ZD - ZB(N) - COMB(N)
      DMEP = T3 * (( (1.2*EP*T4* (ZTEMP/YS) + 1.)**1.66667) - 1.)
C
 30   GEP(N) = DMEC + DMEP
      EEP(N) = 0.24 * TT * GEP(N)
      DO 40 I=1,NSPCS
 40   CEP(I,N) = GEP(N) * CHI(I,IC)
 50   CONTINUE
C
      DO 70 N=1,NFIRES
      GPENT = GPENT + GEP(N)
C
C SAVE THE VALUE OF VOLUME ENTRAINMENT FOR PRINT OUT LATER
C
      FRENTR(N) = GPENT / RO
      EPENT = EPENT + EEP(N)
      DO 60 I=1,NSPCS
 60   CPENT(I) = CPENT(I) + CEP(I,N)
 70   CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE CONV(IC, ZD, TU, TL, QU, QL)
C
C/---------------------------------------------------------------------
C OBJECTIVE
C (1) CONV COMPUTES THE CONVECTIVE HEAT TRANSFER RATE FROM THE UPPER
C     AND LOWER ZONE GAS TO CABIN SURFACES
C
C     QU = TOTAL CONVECTIVE TRANSFER RATE FROM UPPER ZONE (BTU/SEC)
C
C     QL = TOTAL CONVECTIVE TRANSFER RATE FROM LOWER ZONE (BTU/SEC)
C
C     IC = COMPARTMENT NUMBER
C
C     ZD = THERMAL DISCONTINUITY POSITION (FT)
C
C     TU = UPPER ZONE GAS TEMPERATURE (R)
C
C     TL = LOWER ZONE GAS TEMPERATURE (R)
C
C/---------------------------------------------------------------------
C
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DQI,DQM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5             XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6             WMIGF,TKNSIN(7)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSQ,NV,SQWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSQWD,TVSQ,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      DATA H/5.5E-4/
C
      QU = 0.
      QL = 0.
C
      DO 10 I=1,LSN
      CALL COVER(I, IC, ZD, AU, AL)
      QU = QU + H * AU * (TSL(I,2,IC) - TU)
      QL = QL + H * AL * (TSL(I,1,IC) - TL)
 10   CONTINUE
C
      CALL XSEC( ZD  AUPT, ALPT )
      QU = QU + H * AUPT * (TSP(1,2,IC) - TU + TSP(2,2,IC) - TU)
      QL = QL + H * ALPT * (TSP(1,1,IC) - TL + TSP(2,1,IC) - TL)
C
      RETURN
      END
```

```
      SUBROUTINE COVER(IS, IC, ZD, AU, AL)
C
C/----------------------------------------------------------------------
C OBJECTIVE
C (1) COVER COMPUTES THE AREA OF EACH CABIN LINING SURFACE COVERED BY
C      CONTACT WITH EITHER OR BOTH GAS ZONES.
C
C      IS = LINING SURFACE NUMBER
C
C      ZD = DISCONTINUITY POSITION
C
C      AU = AREA (FT*FT) OF SURFACE IS IN CONTACT WITH UPPER ZONE
C
C      AL = AREA (FT*FT) OF SURFACE IS IN CONTACT WITH LOWER ZONE
C
C      SLN= COMPARTMENT LENGTH
C
C/----------------------------------------------------------------------
C
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DQI,DQM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5             XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6             WMIGF,TKNSIN(7)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
C
      SLN = CL(IC)
C
      IF( (SZ(IS) .GE. ZD) .AND. (SZ(IS+1) .GE. ZD) ) GO TO 10
      IF( (SZ(IS) .LT. ZD) .AND. (SZ(IS+1) .LT. ZD) ) GO TO 20
C
      AU = SLN * (SZ(IS) - ZD)
      AL = SLN * (ZD - SZ(IS+1))
C
      IF( SZ(IS) .GT. SZ(IS+1) ) RETURN
C
      AL = - AU
      AU = SLN * ( SZ(IS+1) - ZD )
C
      RETURN
C
 10   XX = ABS( SZ(IS+1) - SZ(IS) )
      IF( XX .LT. 0.5 ) XX = ABS(SX(IS+1) - SX(IS) )
      AU = SLN * XX
      AL = 0.
      RETURN
C
 20   XX = ABS( SZ(IS+1) - SZ(IS) )
```

```
      IF( XX .LT. 0.5 ) XX = ABS( SX(IS+1) - SX(IS) )
      AL = SLN * XX
      AU = 0.
      RETURN
C
      END
```

```
      SUBROUTINE XSEC( ZD, AREA )
C
C/-----------------------------------------------------------------
C OBJECTIVE:
C (1) XSEC COMPUTES THE CROSS-SECTIONAL AREA OF THE LOWER GAS ZONE
C     GIVEN THE THERMAL DISCONTINUITY POSITION ZD (FT).  EFFECT OF SEATS
C     NOT INCLUDED.
C
C     AREA = LOWER ZONE CROSS SECTIONAL AREA (FT*FT)
C
C/-----------------------------------------------------------------
C
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      DIMENSION Y(21)
C
      LSN1 = LSN + 1
C
      DO 10 I=1,LSN1
      Y(I) = SZ(I)
      IF( Y(I) .GT. ZD ) Y(I) = ZD
 10   CONTINUE
C
      SUM = 0.
C
      DO 20 I=1,LSN
 20   SUM = SUM + SX(I) * Y(I+1) - SX(I+1) * Y(I)
      AREA = 0.5 * SUM
C
      RETURN
      END
```

```
      SUBROUTINE FIRE(I, NSPCS, GFB, CFB, EFB)
C
C/-----------------------------------------------------------------
C OBJECTIVE
C (1) FIRE FINDS THE TOTAL RATES OF EMISSION OF MASS, SPECIES, AND
C     ENERGY AT THE BASE PLANES OF ALL FIRES IN COMP I.  SMOKE AND GAS
C     GENERATION BY SMOLDERING SPOTS IS INCLUDED IN THE TOTAL SPECIES
C     RATE
C
C     GFB = TOTAL PYROLYSIS (MASS GENERATION) RATE (LBM/SEC)
C
C     CFB = TOTAL SPECIES GENERATION RATE (SMOKE AND GASES)
C           (LBM/SEC FOR GASES, PART/SEC FOR SMOKE)
C
C     EFB = TOTAL ENERGY (HEAT) GENERATION RATE (BTU/SEC)
C
C/-----------------------------------------------------------------
C
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1              IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2              RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3              TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4              ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5              FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6              IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7              IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8              JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9              NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1              RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2              TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3              FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4              TP(7),TPC(7)
      COMMON /PRTCMN/ ASRFUZ(22,4),ASRFLZ(22,4),CVFLWU(22,4),
     *                CVFLWL(22,4),RDFLWU(22,4),RDFLWL(22,4),
     *                VTFLWV(24,2),VTFLWE(24,2),FBVDOT(30),
     *                FBSDOT(11,30),FBGDOT(30),FRENTR(30)
      DIMENSION CFB(11)
C
C INITIALIZE TOTAL GENERATION RATES
C
      GFB = 0.
      EFB = 0.
      DO 10 N=1,NSPCS
 10   CFB(N) = 0.
C
C IF THERE ARE NO CURRENT FIRES RETURN
C
      IF( NFIRES .EQ. 0 ) RETURN
C
C TOTAL RATE OF PYROLYZATE MASS ADDITION IS FOUND BY SUMMING OVER ALL
C  FIRE BASES
C
      DO 20 N=1,NFIRES
 20   GFB = GFB + RHOZ(N) * UZ(N) * AF(N)
C
C TOTAL RATES OF GAS AND SMOKE GENERATION HAVE BEEN SET IN SUBR AFP
C  UPSTREAM FOR THIS TIME STEP. RATES INCLUDE BOTH FLAMING AND SMLDRNG.
C
      NX = NSPCS - 1
      DO 30 J=1,NX
 30   CFB(J) = GENRAT(J)
```

```
      CFB(NSPCS) = TOTSEM
C
C TOTAL HEAT RELEASE HAS BEEN FOUND IN SUBR TEST UPSTREAM
C
      EFB = TDQ
C
C SAVE THE VOLUME RATE OF FUEL VAPOR GENERATION AT THE FIRE BASE
C
      DO 40 N=1,NFIRES
 40   FBVDOT(N) = UZ(N) * AF(N)
C
      RETURN
      END
```

```
      SUBROUTINE ESET1 ( X, XNEW, NVAR, LDT )
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON /PRTCMN/ ASRFUZ(22, 4), ASRFLZ(22, 4), CVFLWU(22, 4),
     *                CVFLWL(22, 4), RDFLWU(22, 4), RDFLWL(22, 4),
     *                VTFLWV(24, 2), VTFLWE(24, 2), FBVDOT(30),
     *                FBSDOT(11, 30), FBGDOT(30), FRENTR(30)
      DIMENSION X(120), XNEW(120)
C
      DIMENSION XCHIL(11, 5), XCHIU(11, 5), XPF(5), XRHOL(5), XRHOU(5)
      DIMENSION XTU(5), XTL(5), XVOLU(5), XVOLL(5), XZD(5)
      DIMENSION GVU(5),  GVL(5)
      DIMENSION CVU(11, 5),  CVL(11, 5)
      DIMENSION EVU(5),  EVL(5),  GCVNU(4),  GCVNL(4),  GRDU(4),  GRDL(4)
      DIMENSION CFB(11),  CPENT(11)
C
      DIMENSION RHSCU(4),  RHSCL(4),  RHSSU(11, 4),  RHSSL(11, 4)
      DIMENSION RHSEU(4),  RHSEL(4)
      DIMENSION TMASSU(4),  TMASSL(4),  SPCSU(11, 4),  SPCSL(11, 4'
      DIMENSION ENRGYU(4),  ENRGYL(4)
C
      LOGICAL FIRST
C
C THE SWITCH 'FIRST' IS USED TO DIRECT THE EVALUATION OF THE
C  CONSERVATION EQUATIONS. IF FIRST = TRUE EVALUATION IS FOR TIME T.
C  IF FIRST = FALSE EVALUATION IS FOR TIME T + DT.
C
      FIRST =  TRUE.
```

```
C
C VARIABLES RHSCU,    , RHSEL STORE THE RIGHT HAND SIDES OF THE
C  CONSERVATION EQUATIONS EVALUATED AT TIME T.
C
      DO 10 N=1,NCOMPS
      RHSCU(N) = 0.
      RHSCL(N) = 0.
      RHSEU(N) = 0.
      RHSEL(N) = 0.
      DO 5 J=1,NSPCS
      RHSSU(J,N) = 0.
 5    RHSSL(J,N) = 0.
 10   CONTINUE
C
      GO TO 20
C
C ENTRY ESET2 IS USED FOR EVALUATION OF THE VARIABLES AT T + DT.
C
      ENTRY ESET2( X, XNEW, NVAR, LDT )
      FIRST = .FALSE.
C
 20   CALL SCALE(+1,X,NVAR)
C
C CONVERT LDT TO THE TIME STEP, DT, IN SECONDS.
C
      DT = LDT
      DT = DT / 1000.
C
C TRANSFER {X} TO LOCAL WORKING VRBLS WITH DESCRIPTIVE NAMES
C
      I = 0
      DO 30 N2=1,NCOMPS
      DO 25 N1=1,NSPCS
      I = I   + 1
 25   XCHIL(N1,N2) = X(I)
      DO 27 N1=1,NSPCS
      I=I+1
 27   XCHIU(N1,N2) = X(I)
      XPF(N2)    = X(I+1)
      XRHOL(N2) = X(I+2)
      XRHOU(N2) = X(I+3)
      XTL(N2)    = X(I+4)
      XTU(N2)    = X(I+5)
      XVOLL(N2) = X(I+6)
      XVOLU(N2) = X(I+7)
      XZD(N2)    = X(I+8)
 30   I = I + 8
C
C TRANSFER THE VALUES FOR THE EXTERIOR COMPARTMENT
C
      DO 32 N1=1,NSPCS
      XCHIL(N1,5) = CHIL(N1,5)
 32   XCHIU(N1,5) = CHIU(N1,5)
      XPF(5) = PF(5)
      XRHOL(5) = RHOL(5)
      XRHOU(5) = RHOU(5)
      XTL(5) = TL(5)
      XTU(5) = TU(5)
      XZD(5) = ZD(5)
C
C INITIALIZE MASS, SPECIES, AND ENERGY TRANSFER TERMS
```

```
C
      DO 50 I=1,NCOMPS
      GVU(I) = 0.
      GVL(I) = 0.
      DO 40 J=1,NSPCS
      CVU(J,I) = 0.
 40   CVL(J,I) = 0.
C
      EVU(I) = 0.
      EVL(I) = 0.
      QCVNL(I) = 0.
      QCVNU(I) = 0.
      QRDU(I) = 0.
      QRDL(I) = 0.
 50   CONTINUE
C
      GUIJ = 0.
      GLIJ = 0.
      GUJI = 0.
      GLJI = 0.
C
C THIS LOOP OVER ALL VENTS ESTABLISHES THE FLOWS OF MASS, SPECIES, AND
C  ENERGY. ARRAY CNCTNS SHOWS WHICH VENTS CONNECT WHICH COMPARTMENTS.
C  COMPARTMENT 5 IS THE EXTERIOR ALWAYS.
C
      DO 90 IV=1,NV
      I = CNCTNS(IV) / 10.
      J = CNCTNS(IV) - I * 10
      IF( FLOW(IV) .NE. 0. ) GO TO 70
      IF( IV .EQ. IFRVNT ) GO TO 80
C
C SUBR. VENT FINDS FLOW RATES BETWEEN COMPARTMENTS AND TO/FROM
C  THE OUTSIDE.
C
      CALL VENT( IV, XPF(I), XPF(J), XZD(I), XZD(J), XRHOU(I), XRHOU(J),
     *           XRHOL(I), XRHOL(J), GUIJ, GUJI, GLIJ, GLJI )
C
C SAVE THE NET FLOWS OF VOLUME AND ENERGY FOR LATER PRINT OUT
C
 55   CONTINUE
      VTFLWV(IV,2) = ABS( ( GUIJ / XRHOU(I) ) - ( GUJI / XRHOU(J) ) )
      VTFLWV(IV,1) = ABS( ( GLIJ / XRHOL(I) ) - ( GLJI / XRHOL(J) ) )
      XEIJU = GUIJ * CP * XTU(I)
      XEIJL = GLIJ * CP * XTL(I)
      XEJIU = GUJI * CP * XTU(J)
      XEJIL = GLJI * CP * XTL(J)
      VTFLWE(IV,2) = ABS( XEIJU - XEJIU )
      VTFLWE(IV,1) = ABS( XEIJL - XEJIL )
C
C COMPUTE MASS, SPECIES, AND ENERGY FLOW RATES BY COMP. AND ZONE
C
      GVU(I) = GVU(I) - GUIJ + GUJI
      GVL(I) = GVL(I) - GLIJ + GLJI
      GVU(J) = GVU(J) - GUJI + GUIJ
      GVL(J) = GVL(J) - GLJI + GLIJ
C
      DO 60 KK=1,NSPCS
      CVU(KK,I) = CVU(KK,I) - GUIJ * XCHIU(KK,I) + GUJI * XCHIU(KK,J)
      CVL(KK,I) = CVL(KK,I) - GLIJ * XCHIL(KK,I) + GLJI * XCHIL(KK,J)
      CVU(KK,J) = CVU(KK,J) - GUJI * XCHIU(KK,J) + GUIJ * XCHIU(KK,I)
      CVL(KK,J) = CVL(KK,J) - GLJI * XCHIL(KK,J) + GLIJ * XCHIL(KK,I)
```

```
 60   CONTINUE
C
      EVU(I) = EVU(I) - GUIJ * CP * XTU(I) + GUJI * CP * XTU(J)
      EVL(I) = EVL(I) - GLIJ * CP * XTL(I) + GLJI * CP * XTL(J)
      EVU(J) = EVU(J) - GUJI * CP * XTU(J) + GUIJ * CP * XTU(I)
      EVL(J) = EVL(J) - GLJI * CP * XTL(J) + GLIJ * CP * XTL(I)
      GO TO 90
C
C FORCED (PRESCRIBED) FLOW VENT
C
 70   ZZ = XZD(I)
      IF( INTO(IV) .EQ. I ) ZZ = XZD(J)
      FCTR = 1. + ( ZZ - VENTT(IV) ) / VENTH(IV)
      IF( FCTR .GT. 1. ) FCTR = 1.
      IF( FCTR .LT. 0. ) FCTR = 0.
      IF( INTO(IV) .EQ. I) GO TO 75
      GUIJ = XRHOU(I) * FLOW(IV) * (1. - FCTR)
      GLIJ = XRHOL(I) * FLOW(IV) * FCTR
      GO TO 55
 75   GUJI = XRHOU(J) * FLOW(IV) * (1. - FCTR)
      GLJI = XRHOL(J) * FLOW(IV) * FCTR
      GO TO 55
C
C FLOW CONDITIONS AT VENT WITH EXTERIOR FIRE. FLOW IS INTO COMP. J
C
 80   GVU(J) = GVU(J) + RHOEFG * FLOWIN
      GVL(J) = GVL(J) - XRHOL(J) * FLWOUT
      VTFLWV(IV,2) = FLOWIN
      VTFLWV(IV,1) = FLWOUT
C
      DO 82 KK=1,NSPCS
      CVU(KK,J) = CVU(KK,J) + RHOEFG * FLOWIN * CHIEFG(KK)
 82   CVL(KK,J) = CVL(KK,J) - XRHOL(J) * FLWOUT * XCHIL(KK,J)
C
      EVU(J) = EVU(J) + RHOEFG * FLOWIN * CP * TEFG
      EVL(J) = EVL(J) - XRHOL(J) * FLWOUT * CP * XTL(J)
      VTFLWE(IV,2) = FLOWIN * RHOEFG * CP * TEFC
      VTFLWE(IV,1) = FLWOUT * XRHOL(J) * CP * XTL(J)
 90   CONTINUE
C
      DO 100 I=1,NCOMPS
C
C SUBR CONV FINDS THE CONVECTION HEAT TRANSFER FROM THE GAS ZONES TO THE
C  CABIN SURFACES
C
      CALL CONV( I, XZD(I), XTU(I), XTL(I), QCVNU(I), QCVNL(I) )
C
C SUBR RADTN FINDS THE NET RADIATION HEAT TRANSFER FROM THE GAS ZONES TO
C  CABIN SURFACES
C
      CALL RADTN(I,XZD(I),XTU(I),XTL(I),XCHIU,XCHIL,XRHOU(I),XRHOL(I),
     *           NSPCS, XVOLU(I), XVOLL(I), QRDU(I), QRDL(I) )
C
 100  CONTINUE
C
C FOR THE COMPARTMENT CONTAINING INTERIOR FIRES (IF ANY), SUBR PLUME
C  FINDS THE ENTRAINMENT EXCHANGE BETWEEN ZONES
C
      I = IFRCMP
      CALL PLUME( XZD(I), XRHOL(I), XTL(I), XCHIL, NSPCS,  I,
     *            QPENT, CPENT, EPENT )
```

```
C
C SET DTHLF = 0.5 * DT FOR USE IN THE INTEGRATIONS
C
      DTHLF = 0.5 * DT
C
C ON THE FIRST PASS FOR A TIME STEP, JUMP TO STMT 170 TO EVALUATE RHS
C  OF THE CONSERVATION EQUATIONS AT TIME T
C
      IF( FIRST ) GO TO 170
C
C ON SUBSEQUENT PASSES EVALUATE ALL VARIABLES AT TIME T + DT
C
      DO 160 I=1,NCOMPS
      TMASSU(I) = RHSCU(I) + DTHLF * GVU(I)
      TMASSL(I) = RHSCL(I) + DTHLF * GVL(I)
C
      DO 110 J=1,NSPCS
      SPCSU(J,I) = RHSSU(J,I) + DTHLF * CVU(J,I)
 110  SPCSL(J,I) = RHSSL(J,I) + DTHLF * CVL(J,I)
C
      ENRGYU(I) = RHSEU(I) + DTHLF * ( EVU(I) + QCVNU(I) + QRDU(I) )
      ENRGYL(I) = RHSEL(I) + DTHLF * ( EVL(I) + QCVNL(I) + QRDL(I) )
C
C FOR THE COMPARTMENT CONTAINING INTERIOR FIRE(S) ADD THE EFFECTS OF
C  THE PLUME ENTRAINMENT
C
      IF( I .NE. IFRCMP ) GO TO 130
      TMASSU(I) = TMASSU(I) + GPENT * DTHLF
      TMASSL(I) = TMASSL(I) - GPENT * DTHLF
C
      DO 120 J=1,NSPCS
      SPCSU(J,I) = SPCSU(J,I) + CPENT(J) * DTHLF
 120  SPCSL(J,I) = SPCSL(J,I) - CPENT(J) * DTHLF
C
      ENRGYU(I) = ENRGYU(I) + EPENT * DTHLF
      ENRGYL(I) = ENRGYL(I) - EPENT * DTHLF
C
 130  CONTINUE
C
C COMPUTE THE NEW VALUES OF PRESSURE, GAS ZONE VOLUMES, AND LOWER ZONE
C  THICKNESS
C
      PSAVE = XPF(I)
      WMIX = 0.
      IF( XRHOL(I) .EQ. 0. ) GO TO 134
C
      DO 132 J=1,5
 132  WMIX = WMIX + XCHIL(J,I) * WMOLEC(J)
      XPF(I) = XRHOL(I) * RGAS * XTL(I) * GRAV / WMIX
      GO TO 138
C
 134  DO 136 J=1,5
 136  WMIX = WMIX + XCHIU(J,I) * WMOLEC(J)
      XPF(I) = XRHOU(I) * RGAS * XTU(I)  * GRAV / WMIX
 138  CONTINUE
C
      VSAVE = XVOLL(I)
      XVOLL(I) = VTOTAL(I) - XVOLU(I)
C
      WMIX = 0.
      DO 140 J=1,5
```

```
 140  WMIX = WMIX + XCHIU(J,I) * WMOLEC(J)
      XVOLU(I) = XRHOU(I)*XVOLU(I)*RGAS*XTU(I)*GRAV / ( PSAVE * WMIX )
C
      ZDSAVE = XZD(I)
      CALL HEIGHT( I, VSAVE, ZDSAVE, XZD(I) )
C
C FIND THE NEW VALUES OF THE DENSITIES, MASS FRACTIONS, AND TEMPERATURES
C  FROM THE MASSES AND ENERGIES
C
 150  CONTINUE
C
      IF( XVOLU(I) .LE. 0. ) GO TO 152
      XRHOU(I) = TMASSU(I) / XVOLU(I)
C
 152  IF( XVOLL(I) .LE. 0. ) GO TO 154
      XRHOL(I) = TMASSL(I) / XVOLL(I)
C
 154  IF( TMASSL(I) .LE. 0. ) GO TO 156
      DO 155 J=1,NSPCS
 155  XCHIL(J,I) = SPCSL(J,I) / TMASSL(I)
      XTL(I) = ENRGYL(I) / ( CP * TMASSL(I) )
C
 156  IF( TMASSU(I) .LE. 0. ) GO TO 158
      DO 157 J=1,NSPCS
 157  XCHIU(J,I) = SPCSU(J,I) / TMASSU(I)
      XTU(I) = ENRGYU(I) / ( CP * TMASSU(I) )
C
 158  CONTINUE
C
 160  CONTINUE
C
C LOAD THE NEW VARIABLES INTO <XNEW> AND SCALE DOWN TO SCALED MAGNITUDES
C  BEFORE RETURNING
C
      I = 0
C
      DO 165 N2=1,NCOMPS
C
      DO 162 N1=1,NSPCS
      I = I + 1
 162  XNEW(I) = XCHIL(N1,N2)
C
      DO 164 N1=1,NSPCS
      I = I + 1
 164  XNEW(I) = XCHIU(N1,N2)
C
      XNEW(I+1) = XPF(N2)
      XNEW(I+2) = XRHOL(N2)
      XNEW(I+3) = XRHOU(N2)
      XNEW(I+4) = XTL(N2)
      XNEW(I+5) = XTU(N2)
      XNEW(I+6) = XVOLL(N2)
      XNEW(I+7) = XVOLU(N2)
      XNEW(I+8) = XZD(N2)
 165  I = I + 8
C
      CALL SCALE(-1, XNEW, NVAR)
      CALL SCALE(-1, X, NVAR )
C
      RETURN
C
```

```
C ESTABLISH THE PARTS OF THE RIGHT HAND SIDES OF EACH CONSERVATION
C  EQUATION THAT ARE FUNCTIONS OF TIME T
C
 170  CONTINUE
C
      DO 180 I=1,NCOMPS
      RHSCU(I) = XRHOU(I) * XVOLU(I) + DTHLF * GVU(I)
      RHSCL(I) = XRHOL(I) * XVOLL(I) + DTHLF * GVL(I)
C
      DO 172 J=1,NSPCS
      RHSSU(J,I) = XCHIU(J,I) * XRHOU(I) * XVOLU(I) + DTHLF * CVU(J,I)
 172  RHSSL(J,I) = XCHIL(J,I) * XRHOL(I) * XVOLL(I) + DTHLF * CVL(J,I)
C
      RHSEU(I) = CP * XRHOU(I) * XVOLU(I) * XTU(I) + ( EVU(I) + QCVNU(I)
     *           + QRDU(I) ) * DTHLF
      RHSEL(I) = CP * XRHOL(I) * XVOLL(I) * XTL(I) + ( EVL(I) + QCVNL(I)
     *           + QRDL(I) ) * DTHLF
C
C FOR THE COMPARTMENT CONTAINING INTERIOR FIRE(S) ADD THE EFFECTS OF
C  THE PLUME ENTRAINMENT AND GENERATION AT THE FIRE BASES
C
      IF( I .NE. IFRCMP ) GO TO 180
C
      CALL FIRE( I, NSPCS, GFB, CFB, EFB)
C
      RHSCU(I) = RHSCU(I) + DT * GFB + DTHLF * GPENT
      RHSCL(I) = RHSCL(I) - DTHLF * GPENT
C
      DO 174 J=1,NSPCS
      RHSSU(J,I) = RHSSU(J,I) + DT * CFB(J) + DTHLF * CPENT(J)
 174  RHSSL(J,I) = RHSSL(J,I) - DTHLF * CPENT(J)
C
      RHSEU(I) = RHSEU(I) + DT * EFB + DTHLF * EPENT
      RHSEL(I) = RHSEL(I) - DTHLF * EPENT
 180  CONTINUE
C
C SCALE DOWN THE {X} VECTOR TO SCALED MAGNITUDES AND RETURN
C
      CALL SCALE( -1, X, NVAR )
C
      RETURN
      END
```

```
      SUBROUTINE HEIGHT ( IC, VNEW, ZDG, ZD )
C
C/-----------------------------------------------------------------------
C OBJECTIVE
C (1) HEIGHT FINDS THE LOWER ZONE DEPTH (THERMAL DISCONTINUITY POSITION)
C      GIVEN THE LOWER ZONE VOLUME, VNEW, AND A FIRST GUESS AT ZD, ZDG.
C/-----------------------------------------------------------------------
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIME2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXFLINS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9)
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 1
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
C
C INITIALIZE ZD AND RETURN IF VNEW = 0.
C
      ZD = 0.
      IF( VNEW .LE. 0. ) RETURN
C
C MAKE AN INITIAL ESTIMATE OF ZD
C
      ZD1 = ZDG
      ANEW = VNEW / CL(IC)
      ITT = 0
C
C USE SUBR XSEC TO VERIFY THE GUESS
C
 10   ITT = ITT + 1
      CALL XSEC( ZD1, A1 )
C
C CONSIDER ZD TO BE FOUND IF XSEC GIVES A LOWER CROSS-SECTION AREA
C  WITHIN 0.1 % OF THE DESIRED VALUE.
C
      DIFF = ABS( ANEW - A1 )
      TOL = 0.001 * ANEW
      IF( DIFF .LT. TOL ) GO TO 20
C
C ALLOW ONLY 10 TRIES AT THIS ITERATIVE SOLUTION BEFORE STOPPING
C
      IF( ITT .GT. 10 ) GO TO 30
C
C CORRECT THE GUESS IN PROPORTION TO THE DIFFERENCE AND TRY AGAIN
C
      ZD1 = ZD1 * ( 2. - A1 / ANEW )
      GO TO 10
C
 20   ZD = ZD1
      RETURN
C
 30   WRITE(6,99) ITIME, IC, ZDG, ZD, ZD1, ANEW, A1, TOL, DIFF
```

```
99    FORMAT(1H1,2X,'CONVERGENCE FAILURE IN SUBR HEIGHT, TIME =', I10//
     * 2X, I10, 6E15.7 / ( 1X, 6E15.7 ))
      STOP
      END
```

```
      SUBROUTINE RADTN(IC, ZL, TU, TL, CHIU, CHIL, ROU, ROL, NSPCS, VUP,
     *                 VLO, QRU, QRL)
C
C/---------------------------------------------------------------------
C OBJECTIVE
C (1) RADTN FINDS THE NET RADIATION HEAT TRANSFER AMONG THE UPPER
C     AND LOWER GAS ZONES AND THE CABIN SURFACES.
C
C    INPUT VARIABLES:
C
C     IC = COMPARTMENT NUMBER
C
C     ZL = LOWER ZONE DEPTH (FT)
C
C     TU, TL = UPPER AND LOWER ZONE TEMPERATURES (R)
C
C     CHIU, CHIL = UPPER AND LOWER ZONE COMPOSITION ARRAYS (MASS FRAC)
C
C     NSPCS = NUMBER OF SPECIES
C
C     VUP, VLO = UPPER AND LOWER ZONE VOLUMES
C
C    OUTPUT :
C
C     QRU  = NET RADIATION HEAT GAIN RATE BY UPPER ZONE (BTU/SEC)
C
C     QRL  = NET RADIATION HEAT GAIN RATE BY LOWER ZONE (BTU/SEC)
C
C/---------------------------------------------------------------------
C
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DQI,DQM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5             XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6             WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
      DIMENSION CHIU(11,4), CHIL(11,4)
C
      QRU = 0.
      QRL = 0.
C
C FIND APPROXIMATE GAS ZONE SURFACE AREAS
C
      AUT = 2. * ( CL(IC) * CW + ( CH - ZL ) * ( CW + CL(IC) )  )
      ALT = 2. * ( CL(IC) * CW + ZL * ( CW + CL(IC) ) )
C
```

```
C COMPUTE MEAN BEAM LENGTHS (FT)
C
      BLMU = 0
      IF( AUT .NE. 0. ) BLMU = 3.6 * VUP / AUT
      BLML = 0.
      IF( ALT .NE. 0. ) BLML = 3.6 * VLO / ALT
C
C ZONE EMITTANCES (GREY GAS APPROXIMATION)
C
      SCL = CHIL(NSPCS,IC) * ROL
      SCU = CHIU(NSPCS,IC) * ROU
C
      EGL = 1. - EXP ( - ( 0.1054 * SCL + 0.1 ) * BLML )
      EGU = 1. - EXP ( - ( 0.1054 * SCU + 0.1 ) * BLMU )
C
C RDIATION EMITTED BY EACH ZONE
C
      GREMTU = SIGMA * EGU * AUT * (TU **4)
      GREMTL = SIGMA * EGL * ALT * (TL **4)
C
C RADIATION ABSORBED BY EACH ZONE WHICH WAS EMITTED BY SURFACES IN
C  CONTACT WITH IT
C
      XXU = 0.
      XXL = 0.
C
      DO 10 J=1,LSN
C
      CALL COVER(J, IC, ZL, AU, AL )
      XXU = XXU + AU * ( TSL(J,2,IC) **4)
 10   XXL = XXL + AL * ( TSL(J,1,IC) **4)
C
      CALL XSEC( ZL, AUPT, ALPT )
      XXU = XXU + AUPT * (( TSP(1,2,IC))**4 + (TSP(2,2,IC))**4)
      XXL = XXL + ALPT * (( TSP(1,1,IC))**4 + (TSP(2,1,IC))**4)
C
      XXU = XXU + EGL * CW * CL(IC) * TL **4
      XXL = XXL + EGU * CW * CL(IC) * TU **4
C
      GRABU = XXU * SIGMA * EGU
      GRABL = XXL * SIGMA * EGL
C
C NET RADIATION RATE OF HEAT GAIN FOR EACH ZONE
C
      GRU = GRABU - GREMTU
      GRL = GRABL - GREMTL
C
C IF THIS IS THE INTERIOR FIRE COMPARTMENT SET THE FLUX LEVELS GC(1) AND
C  GC(2) FOR USE IN SUBR RATES ON THE NEXT FLAME SPREAD PASS
C
      IF( IC .NE. IFRCMP ) RETURN
C
C COMPUTE APPROXIMATE VIEW FACTOR FOR RADIATION FROM THE UPPER ZONE
C  GAS TO TARGETS IN THE LOWER ZONE
C
      DIST = 2. * ZL
      VF = 1.0
      IF( DIST .LE. 0. ) GO TO 20
      XX = CW / DIST
      YY = CL(IC) / DIST
      XR = SQRT( 1. + XX * XX )
```

```
      YR = SQRT( 1. + YY * YY )
      VF = ( XX * ATAN(YY/XR) / XR ) + ( YY * ATAN(XX/YR) / YR )
      VF = 2. * VF / PI
 20   CONTINUE
C
C FIND QC(2), FLUX TO TARGETS IN THE UPPER ZONE
C
      QC(2) = QREMTU / AUT
C
C FIND QC(1), FLUX TO TARGETS IN THE LOWER ZONE
C
      QC(1) = (1. - EGL) * VF * EGU * SIGMA * (TU**4)
C
      RETURN
      END
```

```
      SUBROUTINE SRFTMP
C
C/-----------------------------------------------------------------------
C
C OBJECTIVES
C (1) SRFTMP COMPUTES THE NEW AVERAGE SURFACE TEMPERATURES OF THE LINING
C     MATERIALS SURFACES AND THE PARTITION SURFACES.
C
C (2) THE CONVECTIVE AND RADIATIVE HEAT FLOWS TO THE SURFACES ARE ALSO
C     COMPUTED FOR OUTPUT DOWNSTREAM
C
C COMMENTS
C (1) THE VIEW FACTOR FOR RADIATION FROM THE UPPER ZONE REACHING SURFS
C     IN CONTACT WITH THE LOWER ZONE IS A CONSTANT (VERY) ROUGH
C     ESTIMATE OF 0.5 IN THIS VERSION
C
C/-----------------------------------------------------------------------
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/RADTN/ALPC, ABSCF(30), EB, QC(2)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
C
      COMMON /PRTCMN/ ASRFUZ(22, 4), ASRFLZ(22, 4), CVFLWU(22, 4),
     *                CVFLWL(22, 4), RDFLWU(22, 4), RDFLWL(22, 4),
     *                VTFLWV(24, 2), VTFLWE(24, 2), FBVDOT(30),
     *                FBSDOT(11, 30), FBGDOT(30), FRENTR(30)
C
      DATA H / 5.5E-4 /
C
      DO 20 ICMP=1, NCOMPS
C
C FIND GAS ZONE BEAM LENGTHS AND EMITTANCES OF EACH GAS ZONE
C
      AUT = 2. * ( CL(ICMP) * CW + ( CH - ZD(ICMP) ) * ( CW + CL(ICMP)))
      ALT = 2. * ( CL(ICMP) * CW + ZD(ICMP) * (CW + CL(ICMP) ) )
```

```
C
      BLMU = 0
      IF( AUT .NE. 0. ) BLMU = 3.6 * VOLU(ICMP) / AUT
      BLML = 0
      IF( ALT .NE. 0. ) BLML = 3.6 * VOLL(ICMP) / ALT
C
      SCU = CHIU(NSPCS,ICMP) * RHOU(ICMP)
      SCL = CHIL(NSPCS,ICMP) * RHOL(ICMP)
C
      EGU = 1. - EXP( -( 0.1054 * SCU + 1.0 ) * BLMU )
      EGL = 1. - EXP( -( 0.1054 * SCL + 1.0 ) * BLML )
C
C FIND THE EMITTED RADIATION BY EACH GAS ZONE ( PER UNIT AREA )
C
      REMUG = EGU * SIGMA * ( TU(ICMP) **4 )
      REMLG = EGL * SIGMA * ( TL(ICMP) **4 )
C
      DO 10 ISRF=1,LSN
C
C SELECT THE MATERIAL NUMBER
C
      IMT = IMATL(ISRF)
C
C RHSU AND RHSL ACCUMULATE THE RIGHT HAND SIDES OF THE DIFFERENTIAL
C  EQUATIONS FOR THE SURFACE TEMPERATURES
C
      RHSU = 0.
      RHSL = 0.
C
C CIN IS THE INSULATION CONDUCTIVITY DIVIDED BY THE MATL THICKNESS
C
      CIN = CNDCTY(IMT) / TKNSIN(IMT)
C
C SUBR COVER FINDS THE CONTACT AREA WITH EACH GAS ZONE, AUPR & ALWR
C
      CALL COVER( ISRF, ICMP, ZD(ICMP), AUPR, ALWR )
C
C COMPUTE THE CONVECTIVE TRANSFER TO/FROM THE SURFACE AND ADD TO THE RHS
C
      TXU = TSL(ISRF,2,ICMP)
      TXL = TSL(ISRF,1,ICMP)
C
      CVNU = H * AUPR * ( TU(ICMP) - TXU )
      CVNL = H * ALWR * ( TL(ICMP) - TXL )
C
      RHSU = RHSU + CVNU
      RHSL = RHSL + CVNL
C
C SUBTRACT THE CONDUCTION LOSS THROUGH THE REAR FACE
C
      RHSU = RHSU - CIN * AUPR * ( TXU - TAM )
      RHSL = RHSL - CIN * ALWR * ( TXL - TAM )
C
C FIND THE INCOMING RADIATION TO THE SURFACE
C
      QRINU = AUPR * REMUG
      VFAC = 0.5
      QRINL = ALWR * REMLG + ALWR * VFAC * REMUG
C
C FIND THE RADIATION EMITTED BY THE SURFACE
C
```

```
      QROUTU = AUPR * SIGMA * ( TXU **4 )
      QROUTL = ALWR * SIGMA * ( TXL **4 )
C
C ADD THE RADIATION  CONTRIBUTIONS TO THE RIGHT HAND SIDES
C
      RHSU = RHSU + QRINU - QROUTU
      RHSL = RHSL + QRINL - QROUTL
C
C COMPUTE THE CHANGES IN TEMPERATURES
C
      DTU = 0.
      DTL = 0.
      DT = IDELT / 1000.
      IF( AUPR .GT. 0. )
     * DTU = ( DT / ( AUPR * CPM(IMT) * RHOM(IMT) * TKNS(IMT))) * RHSU
      IF( ALWR .GT. 0. )
     * DTL = ( DT / ( ALWR * CPM(IMT) * RHOM(IMT) * TKNS(IMT))) * RHSL
C
C UPDATE THE TEMPERATURES OF THE LINING SURFACE
C
      TSL(ISRF,2,ICMP) = TSL(ISRF,2,ICMP) + DTU
      TSL(ISRF,1,ICMP) = TSL(ISRF,1,ICMP) + DTL
C
C SET HIBERNATION VALUES FOR SURF. TEMPS. WHEN CORRESPONDING
C  AREAS ARE ZERO
C
      IF( AUPR .LE. 0. ) TSL(ISRF,2,ICMP) = TSL(ISRF,1,ICMP)
      IF( ALWR .LE. 0. ) TSL(ISRF,1,ICMP) = TSL(ISRF,2,ICMP)
C
C SAVE THE AREAS AND INCOMING FLOWS FOR PRINTING IN SUBROUTINE OUTPUT
C
      ASRFUZ(ISRF,ICMP) = AUPR
      ASRFLZ(ISRF,ICMP) = ALWR
      CVFLWU(ISRF,ICMP) = CVNU
      CVFLWL(ISRF,ICMP) = CVNL
      RDFLWU(ISRF,ICMP) = QRINU
      RDFLWL(ISRF,ICMP) = QRINL
C
 10   CONTINUE
C
C THIS SECTION COMPUTES THE NEW PARTITION SURFACE TEMPERATURES
C
C COMPUTE THE AREA OF CONTACT WITH THE PARTITIONS
C
      CALL XSEC( ZD(ICMP), ALWR )
      CALL XSEC( CH, ATTL )
      AUPR = ATTL - ALWR
C
C SELECT THE MATERIAL PROPERTIES OF THE PARTITION AND INITIALIZE TERMS
C
      IMT = IMTLP(ICMP)
      CIN = CNDCTY(IMT) / TKNSIN(IMT)
      RHSU = 0.
      RHSL = 0.
      TXU = TSP(2,2,ICMP)
      TXL = TSP(2,1,ICMP)
      DTU = 0.
      DTL = 0.
C
C FIND THE CONVECTIVE FLOW TO THE SURFACES
C
```

```
      CVNU = H * AUPR * ( TU(ICMP) - TXU )
      CVNL = H * ALWR * ( TL(ICMP) - TXL )
C
      RHSU = RHSU + CVNU
      RHSL = RHSL + CVNL
C
C SUBTRACT THE CONDUCTION LOSS
C
      RHSU = RHSU - CIN * AUPR * ( TXU - TAM )
      RHSL = RHSL - CIN * ALWR * ( TXL - TAM )
C
C FIND THE INCOMING RADIATION AND EMITTED RADIATION
C
      QRINU = AUPR * REMUG
      VFAC = 0.5
      QRINL =  ALWR * REMLG + ALWR * VFAC * REMUG
      QROUTU = AUPR * SIGMA * ( TXU **4 )
      QROUTL = ALWR * SIGMA * ( TXU **4 )
C
C ADD THE RADIATION TERMS TO THE RIGHT HAND SIDES
C
      RHSU = RHSU + QRINU - QROUTU
      RHSL = RHSL + QRINL - QROUTL
C
C FIND THE TEMPERATURE CHANGES AND UPDATE THE TEMPERATURES
C
      IF( AUPR .GT. 0. )
     * DTU = ( DT / ( AUPR * CPM(IMT) * RHOM(IMT) * TKNS(IMT) ) ) * RHSU
      IF( ALWR .GT. 0. )
     * DTL = ( DT / ( ALWR * CPM(IMT) * RHOM(IMT) * TKNS(IMT) ) ) * RHSL
      TSP(1,2,ICMP) = TSP(1,2,ICMP) + DTU
      TSP(2,2,ICMP) = TSP(2,2,ICMP) + DTU
      TSP(1,1,ICMP) = TSP(1,1,ICMP) + DTL
      TSP(2,1,ICMP) = TSP(2,1,ICMP) + DTL
C
C SET HIBERNATION VALUES FOR THE SURFACE TEMPS WHEN CORRESPONDING
C  AREAS ARE ZERO
C
      IF( AUPR .GT. 0. ) GO TO 12
      TSP(1,2,ICMP) = TSP(1,1,ICMP)
      TSP(2,2,ICMP) = TSP(2,1,ICMP)
 12   CONTINUE
      IF( ALWR .GT. 0. ) GO TO 14
      TSP(1,1,ICMP) = TSP(1,2,ICMP)
      TSP(2,1,ICMP) = TSP(2,2,ICMP)
 14   CONTINUE
C
C SAVE THE AREAS AND INCOMING FLOWS
C
      ASRFUZ(21,ICMP) = AUPR
      ASRFLZ(21,ICMP) = ALWR
      CVFLWU(21,ICMP) = CVNU
      CVFLWL(21,ICMP) = CVNL
      RDFLWU(21,ICMP) = QRINU
      RDFLWL(21,ICMP) = QRINL
C
      ASRFUZ(22,ICMP) = AUPR
      ASRFLZ(22,ICMP) = ALWR
      CVFLWU(22,ICMP) = CVNU
      CVFLWL(22,ICMP) = CVNL
      RDFLWU(22,ICMP) = QRINU
```

```
      RDFLWL(22,ICMP) = QRINL
C
 20   CONTINUE
C
      RETURN
C
      END
```

```
      SUBROUTINE SCAN(I)
C ------------------------------------------------------------------
C OBJECTIVE(S)
C (1) SUBR SCAN SCANS THE ARRAYS OF LINING SURFACE AND SEAT ELMNTS TO
C     ISOLATE GROUPS OF CONTIGUOUS FLAMING ELMNTS WHICH FORM THE BASE
C     AREAS OF FIRES. WHEN A GROUP OF ELMNTS IS DISCOVERED THE FOLLOWING
C     QUANTITIES ARE COMPUTED AND ASSIGNED TO THIS NEW FIRE --
C
C     K      = FIRE NUMBER  ( A COMPLETE RENUMBERING OCCURS AT EACH FLAME
C                             SPREAD PASS )
C     AF     = FIRE BASE AREA
C
C     IVMAX, IVMIN, JVMAX, JVMIN, IVMX, IVMN, JVMX, JVMN  = MAXIMUM AND
C              MINIMUM VALUES OF THE I AND J INDICES  OF THE ELMNTS
C              COMPOSING THE FIRE BASE. TWO COPIES ARE KEPT.
C
C     ISTART, JSTART, IEND, JEND  =  I AND J INDEX VALUES DEFINING THE
C              REGION OVER WHICH THE SEARCH FOR FIRES WAS JUST
C              CONDUCTED.
C
C     ZB     = THE DISPLACEMENT OF THE CENTER OF THE FIRE BASE FROM THE
C             FLOOR
C
C     YZ     = THE HYDRAULIC RADIUS OF THE FIRE BASE AREA
C
C     FLML   = THE FLAME LENGTH FOR THE FIRE
C
C     ALPC   = THE FLAME BASE CENTER EMITTANCE FOR THIS FIRE
C
C     ISFIRE= SEAT GROUP NUMBER (IF ANY) ON WHICH THIS FIRE IS BURNING
C             VALUE OF ZERO => FIRE IS ON LINING SURFACES.
C
C     IZONE = THE GAS ZONE IN WHICH THE BASE CENTER OF THIS FIRE IS
C             LOCATED. VALUE = 1 => LWR ZONE, = 2 => UPPER ZONE.
C
C     IXFIRE= FLAG TO IDENTIFY WHICH PART OF A SEAT GROUP ON WHICH A
C             SEAT FIRE IS LOCATED (USED ON SEAT FIRES ONLY)
C              IXFIRE = 1 => FIRE IS ON CUSHION BOTTOM
C              IXFIRE = 2 => FIRE IS ON CUSHION TOP AND FRONT
C              IXFIRE = 3 => FIRE IS ON BACKREST
C
C     FSN1, FSN2, FSN3 = NUMBERS OF FLAMING ELMNTS ON THE CUSHION BOTTOM
C             CUSHION TOP, AND BACKREST RESPECTIVELY, OF A FIRE BURNING
C             ON A SEAT GROUP. USED ONLY FOR SEAT FIRES.
C
C     NSFL   = THE NUMBER OF FLAMING ELMNTS OF EACH OF THE 7 SURFACES OF
C             A SEAT GROUP. USED ONLY FOR SEAT FIRES.
C
C     PDH    = THE SMOLDERING RANGE FOR THE FIRE.
C
C     COMB   = THE COMBUSTION ZONE LENGTH.
C
C     GAMMA = THE STOICHIOMETRIC OXYGEN-TO-FUEL RATIO.
C
C     OMEGA = THE INVERSE VOLUMETRIC EXPANSION RATIO.
C
C     RHOZ   = THE FUEL VAPOR DENSITY AT THE FIRE BASE PLANE.
C
C     UZ     = THE FUEL VAPOR VELOCITY AT THE BASE PLANE.
C
C     RADFIR= THE RADIATION LOSS FRACTION FOR THIS FIRE.
```

```
C
C      IF THIS FIRE CONTAINS IGNITION SOURCE ELEMENTS --
C
C      AEXP  = THE DIFFERENCE, IF ANY, BETWEEN THE TOTAL BASE AREA FOR
C              THIS FIRE AND THE AREA COMPOSED OF IGNITION SOURCE ELMNTS.
C
C      ALSO, SUBR SCAN SETS NEW VALUES FOR --
C
C      ISAVE = A FLAG TO CONTROL SUBSEQUENT CALLS TO THIS SUBROUTINE
C              FOR THE SAME SURFACE NUMBER (SEE COMMENT 1).
C
C      IF    = AN ARRAY INDICATING FOR EACH ELEMENT HOW MANY NEIGHBORING
C              ELEMENTS TO THAT ELEMENT ARE IN THE FLAMING STATE.
C COMMENTS
C (1) THE USE OF SUBR SCAN IS AS FOLLOWS. AT THE START OF A FLAME SPREAD
C     CALCULATION SCAN IS CALLED FOR EACH SURFACE IN SEQUENCE. WHEN A
C     FIRE IS DISCOVERED AND ITS PROPERTIES AND LIMITS DETERMINED,
C     CONTROL LEAVES SUBR SCAN AND GOES TO SUBRS COND, FCON, ETC. EVEN
C     THOUGH THERE MAY BE ADDITIONAL FIRES ON THE CURRENT SURFACE. IF
C     THERE ARE OTHER FIRES, THE FLAG ISAVE IS USED TO DIRECT CONTROL
C     BACK TO SCAN AGAIN WITHOUT SKIPPING TO A NEW SURFACE. WHEN A FIRE
C     BASE OVERLAPS TWO OR MORE CO-PLANAR LINING SURFACES THE VALUE OF
C     I IN THE CALL MAY BE CHANGED BUT ALL FIRES ON THE CO-PLANAR SET OF
C     LINING SURFACES WILL BE DISCOVERED THRU THE USE OF ISAVE.
C (2) DUE TO THE DESIGN DESCRIBED ABOVE SUBR SCAN DEPENDS UPON THE
C     RETENTION OF THE VALUES OF SOME LOCAL (INTERNAL) VARIABLES
C     BETWEEN CALLS.
C -----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1            IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2            ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3            JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1            IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2            RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3            TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4            ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5            FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6            IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7            IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8            JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9            NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1            RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2            TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3            FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4            TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1            RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2            VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3            JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1            IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2            CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3            ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4            ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5            ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6            IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7            SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8            XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9            HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1            CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
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     2                FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1                FOX(7),NMATLS,DGI,DGM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2                ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3                ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4                RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5                XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6                WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
C THE LOCAL ARRAYS IFR AND JFR WILL BE FILLED WITH THE I AND J INDICES
C OF ELMNTS IN STATE 3 (FLAMING).  THEY ARE THE WORKING MATERIAL FOR
C CONSTRUCTING FIRE BASE AREAS.  THE ARRAY IUSE WILL CONTAIN A CODE FOR
C EACH FLAMING ELMNT SIGNALING IF IT HAS YET TO BE INCLUDED IN A FIRE
C BASE.  IFR, JFR, AND IUSE ARE SINGLY DIMENSIONED AT A LARGE ENOUGH
C VALUE TO COVER ALL LINING SURFACE AND SEAT ELMNTS.  SINGLE DIMENSIONING
C IS USED TO FACILITATE SHIFTING DATA WITHIN THE ARRAYS.   TEMJ AND QCMB
C ARE TEMPORARY WORKING ARRAYS.
      DIMENSION IFR(620),JFR(620),IUSE(620),TEMJ(7),QCMB(50)
C IF ISAVE IS ZERO THIS IS THE FIRST EXAMINATION OF THIS SURFACE SO SKIP
C TO STMT 1 FOR SOME INITIALIZATION OF WORKING VRBLS.
      IF(ISAVE.EQ.0) GO TO 1
C THIS TEST PROTECTS AGAINST AN ERRONEOUS RE-CALL OF THIS SUBR.  NTOT IS
C A COUNT OF THE NUMBER OF FIRE BASE ELMNTS DISCOVERED.
      IF(NTOT.EQ.0) GO TO 173
      GO TO 3
C ON THE FIRST PASS FOR A SURFACE INITIALIZE THE COUNTERS FSN1, FSN2,
C FSN3 AND NSFL.
    1 FSN1=0.0
      FSN2=0.
      FSN3=0.
      DO 2 KS=1,7
 2    NSFL(KS)=0
C INITIALIZE THE ARRAY IF.
3     DO 20 IJ=1,600
 20   IF(IJ)=0
C THIS TEST SKIPS CONTROL TO STMT 30 ON THE FIRST CALL FOR SURFACE I.
      IF(ISAVE.EQ.0) GO TO 30
C ICTR IS A COUNTER OF THE CURRENT LOCATION IN THE IFR AND JFR ARRAYS
C SET IT TO 1 TO START.
      ICTR=1
C IF THIS SURFACE, I, IS A SEAT GROUP (AND THIS IS THE SECOND OR
C SUCCEEDING SCAN OF THIS SURF) SKIP TO STMT 22 TO SET UP SPECIAL I AND
C J INDEX LIMITS FOR SCANNING OF SEAT GROUP SURFACES.
      IF(I.GT.LSN)GO TO 22
C FOR LINING SURFACES ESTABLISH J INDEX SCAN LIMITS AND SKIP TO 176.
      J1=1
      J2=JEND
      GO TO 176
C ICOUNT IS A SWITCH TO INDICATE WHICH SEAT SURFACES HAVE BEEN SCANNED
C THE TEST ON ICOUNT = 0 IS A PROTECTION AGAINST ERRONEOUS CALLS.
 22   IF(ICOUNT.EQ.0)GO TO 173
C THIS COMPUTED GO-TO SWITCHES CONTROL TO STMTS WHICH SEARCH VARIOUS
C PARTS OF THE SEAT GROUP FOR FLAMING ELMNTS. THE DECISION IS BASED ON
C WHICH PARTS HAVE BEEN SCANNED IN EARLIER CALLS. THE SCANNING STMTS ARE
C 23 THRU 28 AND 1741 THRU 1746. * SOME CLEAN-UP IS NEEDED HERE *
      GO TO (1741,1742,1744,1744,24), ICOUNT
 23   IBK=1
      ION=6
      ITWO=7
      GO TO 25
```

```
 24    IBK=2
       ION=5
       ITWO=18
 25    DO 27 NN=1,NTOT
       IF(JFR(NN).GE.ION .AND. JFR(NN).LE.ITWO)GO TO 28
 27    CONTINUE
       IF(IBK-1)1744,1744,1745
 28    IF(IBK-1)1743,1743,1746
C IF CONTROL REACHES THIS POINT, THIS IS THE FIRST SCAN OF THIS SURFACE
C ON THIS SPREAD PASS SO START WITH THE MINIMUM I AND J INDICES FOR THE
C SURFACE
 30    ISTART=IMIN(I)
       JSTART=JMIN(I)
C FOR LINING SURFACES THE SCANNING PROCESS WILL TAKE PLACE OVER ALL
C ADJACENT CO-PLANAR SURFACES. STMTS 110 THRU 160 FIND THE MAXIMUM I AND
C J INDICES FOR SCANNING IN THIS CASE.
       IF(I.LE.LSN) GO TO 110
       IS=I-LSN
       GO TO 160
 110   IP=0
 120   IF((I+IP+1).LE.LSN) GO TO 130
       I=I+IP
       GO TO 160
 130   IP=IP+1
       IT=I+IP
       DO 140 IX=1,3
       IF(VN(I,IX).NE.VN(IT,IX)) GO TO 150
 140   CONTINUE
       GO TO 120
 150   I=I+IP-1
 160   IEND=IMAX(I)
       JEND=JMAX(I)
       ICTR=0
C THE NESTED LOOPS THRU 165 AND 170 SEARCH OVER THE REGION OF ELMNTS
C DEFINED BY ISTART, IEND, JSTART, AND JEND TO SET UP THE LISTS (ARRAYS)
C IFR AND JFR WHICH CONTAIN THE I AND J INDICES  OF ALL STATE 3 ELMNTS
C WITHIN THIS REGION. ICTR IS THE COUNTER OF THE TOTAL NUMBER FOUND.
C ALSO THE MARKER LIST IUSE IS INITIALIZED TO ZERO AND, IF THIS IS A
C SEAT, NSFL IS FILLED WITH THE NUMBER OF STATE 3 ELMNTS ON EACH OF THE
C SEAT SURFACES.
       DO 170 II=ISTART,IEND
       DO 165 JJ=JSTART,JEND
       CALL CVOUT(II,JJ,I,IST,ISTP,ITFCP)
       IF(IST.NE.3 .OR. IST.NE.ISTP) GO TO 165
 162   ICTR=ICTR+1
       IFR(ICTR)=II
       JFR(ICTR)=JJ
       IUSE(ICTR)=0
       IF(I.LE.LSN) GO TO 165
       KS=IRAYS(JJ)
       NSFL(KS)=NSFL(KS)+1
 165   CONTINUE
 170   CONTINUE
C SAVE THE TOTAL NUMBER OF FLAMING ELMNTS DISCOVERED AS NTOT.
       NTOT=ICTR
C IF NO FLAMING ELMNTS WERE FOUND IN THE SCANNED REGION SET THE ISAVE
C FLAG TO ALLOW PROGRESS TO NEW SURFACES AND RETURN.
 171   IF(ICTR.GT.0)GO TO 174
 173   ISAVE=0
       RETURN
C THE FOLLOWING 27 STMTS REARRANGE THE ENTRIES IN THE IFR AND JFR ARRAYS
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C IN THE CASE OF SEAT SURFACES ONLY   THE OBJECTIVE IS TO PLACE ALL
C INDICES OF ELMNTS ON THE SEAT CUSHION BOTTOM FIRST IN THE ARRAYS. THE
C INDICES OF CUSHION TOP AND FRONT ELMNTS SECOND. AND THE INDICES OF
C BACKREST ELMNTS LAST.  THIS ORDERING IS REQUIRED BY THE CONVENTION
C THAT ALL BURNING ELMNTS ON ANY ONE OF THESE THREE PARTS OF A SEAT
C ARE REGARDED AS COMPRISING A SINGLE FIRE ON THAT PART.
174   IF(I.LE.LSN)GO TO 1740
      ILOC=310
      DO 1800 IL=1,NTOT
      IF(JFR(IL).GT.4) GO TO 1800
      ILOC=ILOC+1
      JFR(ILOC)=JFR(IL)
      IFR(ILOC)=IFR(IL)
1800  CONTINUE
      IF((ILOC-310).GE.NTOT)GO TO 1850
      DO 1810 IL=1,NTOT
      IF(JFR(IL).LT.19)GO TO 1810
      ILOC=ILOC+1
      JFR(ILOC)=JFR(IL)
      IFR(ILOC)=IFR(IL)
1810  CONTINUE
      IF((ILOC-310).GE.NTOT)GO TO 1850
      DO 1820 IL=1,NTOT
      IF(JFR(IL).LT.5 .OR. JFR(IL).GT.18) GO TO 1820
      ILOC=ILOC+1
      JFR(ILOC)=JFR(IL)
      IFR(ILOC)=IFR(IL)
1820  CONTINUE
1850  ILOC=310
      DO 1860 IL=1,NTOT
      ILOC=ILOC+1
      IFR(IL)=IFR(ILOC)
1860  JFR(IL)=JFR(ILOC)
      GO TO 1741
C FOR LINING SURFACES SET THE VALUES FOR THE LIMITS OF THE J INDICES
C ON A SURFACE TO 1 AND JEND.  J1 IS THE LOWEST J VALUE ON THE SURF AND
C J2 IS THE HIGHEST.
1740  J1=1
      J2=JEND
      GO TO 175
C THE NEXT 27 STMTS DEFINE THE J INDEX LIMITS FOR SEAT GROUPS AND SET
C THE VALUE OF IXFIRE FOR USE IN THE SPREAD SUBROUTINES CONDS AND FCONS.
C ICOUNT IS ALSO SET TO CONTROL SEAT SCANNING DURING ANY SUBSEQUENT
C CALLS.
 1741 ICOUNT=2
      IXFIRE=0
      IF(NSFL(1).LT.1)GO TO 1742
C SET J LIMITS FOR CUSHION BOTTOM.
      J1=1
      J2=4
      IXFIRE=1
      ISAVE=1
      GO TO 175
 1742 IF(NSFL(6).GT.0 .OR. NSFL(7).GT.0)GO TO 1743
      ICOUNT=4
      GO TO 1744
C SET J LIMITS FOR CUSHION TOP.
 1743 J1=19
      J2=22
      ICOUNT=3
      IXFIRE=2
```

```
      ISAVE=1
      GO TO 175
 1744 IF(NSFL(2).GT.0 .OR. NSFL(3).GT.0)GO TO 1746
      IF(NSFL(4).GT.0 .OR. NSFL(5).GT.0)GO TO 1746
C NO FLAMING ELMNTS HAVE BEEN DETECTED ON THE SEAT. RETURN TO MAIN PGM
 1745 IXFIRE=0
      ICOUNT=0
      GO TO 173
C SET J LIMITS FOR BACKREST.
 1746 J1=5
      J2=18
      IXFIRE=3
      ICOUNT=5
      ISAVE=1
C CONTROL REACHES THIS POINT FOR BOTH SEATS AND LINING SURFACES.
C THE TEST IS MADE TO FIND IF THE CURRENT SURFACE CONTAINS THE IGN SRC
C FIRE. IF IT DOES, THIS FIRE IS ISOLATED IN THE LOOPS THRU 1750 AND
C 1751 AND THE IF ARRAY IS COMPUTED FOR THE ELMNTS OF THE IGN SRC FIRE
C SEE SUBR ISIDE FOR THE DEFINITION OF THE ARRAY IF.
175   CONTINUE
      IF(IGNFIR.NE.1.OR.I.NE.IGSN) GO TO 176
      NSQ=0
      PERIM=PIGN
      ICON=IEND-ISTART+1
      DO 1751 IL=1,NTOT
      DO 1750 L=1,NIJSQ
      IF(IGNIJ(1,L).NE.IFR(IL).OR.IGNIJ(2,L).NE.JFR(IL)) GO TO 1750
      IUSE(IL)=1
      IT=1
      IF(JFR(IL).EQ.IGMNJ) IT=2
      IF(JFR(IL).EQ.IGMXJ) IT=IT+10
      IF(IFR(IL).EQ.IGMNI) IT=IT+100
      IF(IFR(IL).EQ.IGMXI) IT=IT+1000
      IJ=(IFR(IL)-ISTART+1)+ICON*(JFR(IL)-JSTART)
      IF(IJ)=IT
      NSQ=NSQ+1
 1750 CONTINUE
 1751 CONTINUE
C IGNFIR = 2 IS A FLAG INDICATING THAT THE IGNITION SOURCE FIRE IS
C CURRENTLY BURNING. BECAUSE THE IGN SRC FIRE IS ALWAYS HANDLED
C SEPARATELY CONTROL NOW GOES TO STMT 350 FOR THE COMPUTATION OF
C INDEX LIMITS, FLAME LENGTH, ETC.
      IGNFIR=2
      GO TO 350
C STMT 176 IS THE STARTING POINT FOR THE PROCESS, GIVEN IN THE NEXT 128
C STMTS (THRU 348), WHICH IDENTIFIES THE GROUPS OF CONTIGUOUS ELMNTS
C WHICH FORM A FIRE BASE. THE PROCESS WORKS AS FOLLOWS. START WITH THE
C FIRST ELMNT GIVEN BY THE I AND J INDICES STORED IN THE FIRST POSITION
C OF THE IFR AND JFR ARRAYS. THE EIGHT IMMEDIATELY NEIGHBORING ELMNTS
C ARE THEN EXAMINED TO FIND WHICH, IF ANY, ARE FLAMING. FLAMING
C NEIGHBORS ARE MARKED BY SETTING THEIR CORRESPONDING MEMBER OF THE
C ARRAY IUSE TO A NON-ZERO INTEGER.  WHEN ALL FLAMING NEIGHBORS OF A
C FLAMING ELMNT HAVE BEEN FOUND CONTROL MOVES TO THE NEXT MEMBER OF
C THE IFR AND JFR LISTS AND THE SEARCH OF NEIGHBORS REPEATS.
C EVENTUALLY ALL FLAMING ELMNTS IN A FIRE BASE WILL HAVE BEEN MARKED
C AS BEING A NEIGHBOR TO ANOTHER FLAMING ELMNT  CONTROL THEN SKIPS TO
C STMT 350 FOR COMPUTATION OF THE FIRE PROPERTIES.
 176  ICON=IEND-ISTART+1
C SELECT AS THE TEST ELMNT THE ONE GIVEN BY THE FIRST MEMBERS OF THE IFR
C AND JFR ARRAYS
      ICTR=1
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      II=IFR(ICTR)
      JJ=JFR(ICTR)
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
      IF(NTOT-1) 173,180,190
C IF NTOT = 1 THIS IS A SINGLE ELEMENT FIRE
 180  NSQ=1
      PERIM=4.*SQD
      IF(IJ)=1112
      IUSE(ICTR)=1
      ISAVE=0
      GO TO 350
C THE FIRE BASE CONSISTS OF MORE THAN ONE ELMNT. INITIALIZE SEVERAL
C COUNTERS: NOP = NUMBER OF ELMNTS ON THE FIRE BASE PERIMETER
C           NSQ = TOTAL NUMBER OF ELMNTS ON THE BASE
C           PERIM = THE BASE PERIMETER LENGTH.
C           NFOUND = NUMBER OF THE EIGHT POSSIBLE NEIGHBORS THAT ARE
C                    ALSO FLAMING
C           IBASE = A MARKER FOR POSITION IN THE IFR AND JFR LISTS
C           NBASE = THE NUMBER OF THE FIRE BASE AREA
C           NUSE, NOB = TEMPORARY FLAGS USED IN MARKING NEIGHBORS.
 190  NSQ=0
      PERIM=0.0
      NOP=0
      IUSE(1)=1
      NFOUND=0
      IBASE=1
      NBASE=1
      NUSE=0
      NOB=1
C CHOOSE A FLAMING ELMNT GIVEN BY INDICES II AND JJ AS DETERMINED WITH
C THE CURRENT VALUE OF IBASE
 192  II=IFR(IBASE)
      JJ=JFR(IBASE)
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
      IF(IJ)=1
      NSQ=NSQ+1
C CHOOSE THE NEIGHBORING ELMNT HAVING A LOWER J INDEX, BUT SKIP THIS
C CHOICE IF II, JJ IS ON THE MINIMUM J EDGE.
      IF(JJ.LE.J1)GO TO 217
      IT1=II
      IT2=JJ-1
      IRET=1
C THE FLAG KLOSE SIGNALS BY A VALUE OF ZERO THAT AT LEAST ONE OF THE
C NEIGHBORS OF A FLAMING ELMNT IS NON-FLAMING SO THAT THE FLAMING ELMNT
C MUST LIE ON THE EDGE (PERIMETER) OF A FIRE BASE.
 200  KLOSE=1
C THE LOOP THRU STMT 205 CHECKS ALL MEMBERS OF THE IFR AND JFR ARRAYS
C TO FIND IF THE NEIGHBOR IS LISTED.  IF SO IT IS MARKED - IF IT HAS NOT
C BEEN MARKED ALREADY.
      DO 205 IL=1,NTOT
      IF(IL.EQ.IBASE)GO TO 205
      IF(IT1.NE.IFR(IL) .OR. IT2.NE.JFR(IL)) GO TO 205
      IF(IUSE(IL).NE.0)GO TO 207
      NFOUND=NFOUND+1
      IUSE(IL)=NOB+1
      GO TO 207
 205  CONTINUE
      KLOSE=0
C THIS COMPUTED GO-TO CONTROLS THE SELECTION OF THE NEXT NEIGHBORING
C ELMNT TO BE EXAMINED.
 207  GO TO (215,225,235,245), IRET
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 215  IF(KLOSE.EQ.1) GO TO 220
C ELMNT II, JJ-1 IS NOT FLAMING => II, JJ IS ON THE PERIMETER
 217  NOP=NOP+1
      IF(IJ)=2
C SELECT THE NEIGHBOR HAVING THE NEXT HIGHER J INDEX VALUE, BUT SKIP IT
C IF II, JJ IS ON THE MAXIMUM J EDGE.
 220  IF(JJ.GE.J2)GO TO 227
      IT1=II
      IT2=JJ+1
      IRET=2
      GO TO 200
 225  IF(KLOSE.EQ.1) GO TO 230
C ELMNT II, JJ+1 IS NOT FLAMING => II, JJ IS ON THE PERIMETER
 227  NOP=NOP+1
      IF(IJ)=IF(IJ)+10
 230  IF(II.EQ.ISTART) GO TO 237
C SELECT THE NEIGHBOR HAVING THE NEXT LOWER I INDEX VALUE, BUT SKIP IT
C IF II, JJ IS ON THE MINIMUM I EDGE.
      IT1=II-1
      IT2=JJ
      IRET=3
      GO TO 200
C ELMNT II-1, JJ IS NOT FLAMING => II, JJ IS ON THE PERIMETER.
 235  IF(KLOSE.EQ.1) GO TO 240
 237  NOP=NOP+1
      IF(IJ)=IF(IJ)+100
C SELECT THE NEIGHBOR HAVING THE NEXT HIGHER I INDEX VALUE, BUT SKIP IT
C IF II, JJ IS ON THE MAXIMUM I EDGE.
 240  IF(II.EQ.IEND) GO TO 247
      IT1=II+1
      IT2=JJ
      IRET=4
      GO TO 200
 245  IF(KLOSE.EQ.1) GO TO 250
C ELMNT II+1, JJ IS NOT FLAMING => II, JJ IS ON THE PERIMETER.
 247  NOP=NOP+1
      IF(IJ)=IF(IJ)+1000
C FOR LINING SURFACE ELMNTS SKIP TO THE CONSIDERATION OF NEIGHBORS AT
C THE CORNERS OF ELMNT II, JJ.
 250  IF(I.LE.LSN)GO TO 299
C FOR SEATS COMPUTE THE PERIMETER FOUND SO FAR. THEN IF ALL FLAMING
C ELMNTS ON THE SEAT PART (CUSH. BOTTOM, CUSH. TOP, OR BACK REST) HAVE
C BEEN CHECKED FOR FLAMING NEIGHBORS SKIP TO STMT 350. IF NOT SET IBASE
C TO THE HIGHEST INDEX IN THE IFR AND JFR ARRAYS SO FAR USED AND RETURN
C TO STMT 192 FOR ADDITIONAL CHECKING OF NEIGHBORS BEYOND THAT INDEX.
      TEMP=NOP
      PERIM=PERIM+TEMP*SQD
      NOP=0
 275  IF(ICTR.GE.NTOT)GO TO 350
      ICTR=ICTR+1
      IF(JFR(ICTR).LT.J1 .OR. JFR(ICTR).GT.J2)GO TO 275
      IUSE(ICTR)=1
      IBASE=ICTR
      GO TO 192
C FOR LINING SURFACES TEST THE NEIGHBORS AT THE CORNERS OF ELMNT II, JJ
C TO FIND IF ANY ARE FLAMING, STARTING FIRST WITH II+1, JJ-1  BUT SKIP
C THIS ELMNT IF II, JJ IS ON THE MAX I OR MIN J EDGE.
 299  IF(II.GE.IEND .OR. JJ.LE.J1)GO TO 315
      IT1=II+1
      IT2=JJ-1
      IRET=1
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 300   DO 305 IL=1,NTOT
C THIS LOOP THRU 305 HAS THE SAME FUNCTION AS THAT THRU STMT 205; TO
C FIND AND TO MARK NEIGHBORING ELMNTS ALSO FLAMING.
       IF(IL.EQ.IBASE)GO TO 305
       IF(IT1.NE.IFR(IL) .OR. IT2.NE.JFR(IL)) GO TO 305
       IF(IUSE(IL).NE.0)GO TO 307
       NFOUND=NFOUND+1
       IUSE(IL)=NOB+1
       GO TO 307
 305   CONTINUE
C THIS COMPUTED GO-TO CONTROLS THE SELECTION OF THE NEXT NEIGHBORING
C ELMNT TO BE EXAMINED.
 307   GO TO (315,325,335,340),IRET
 315   CONTINUE
C SELECT THE NEIGHBOR II+1, JJ+1, BUT SKIP IT IF II, JJ IS ON THE MAX I
C OR MAX J EDGE.
       IF(II.GE.IEND .OR. JJ.GE.J2)GO TO 325
       IT1=II+1
       IT2=JJ+1
       IRET=2
       GO TO 300
 325   CONTINUE
C SELECT THE NEIGHBOR II-1, JJ+1, BUT SKIP IT IF II, JJ IS ON THE MIN I
C OR MAX J EDGE.
       IF(II.LE.1 .OR. JJ.GE.J2)GO TO 335
       IT1=II-1
       IT2=JJ+1
       IRET=3
       GO TO 300
 335   CONTINUE
C SELECT THE NEIGHBOR II-1, JJ-1, BUT SKIP IT IF II, JJ IS ON THE MIN I
C OR MIN J EDGE.
       IF(II.LE.1 .OR.JJ.LE.J1)GO TO 340
       IT1=II-1
       IT2=JJ-1
       IRET=4
       GO TO 300
C COMPUTE FIRE PERIMETER.
 340   TEMP=NOP
       PERIM=PERIM+TEMP*SQD
       NOP=0
 345   CONTINUE
C THE FOLLOWING 13 STMTS TEST TO DETERMINE THE NUMBER OF NEWLY
C DISCOVERED FLAMING ELMNT NEIGHBORS. IF SOME HAVE BEEN FOUND DURING
C THE LAST SCAN CONTROL RETURNS TO STMT 192 TO CONTINUE SCANNING. IF
C NONE HAVE BEEN FOUND CONTROL SKIPS TO STMT 350 TO START THE
C COMPUTATION OF FIRE PROPERTIES.
       NUSE=NUSE+1
       IF(NUSE.LT.NBASE)GO TO 346
       IF(NFOUND.EQ.0)GO TO 350
       NBASE=NFOUND
       NFOUND=0
       NUSE=0
       NOB=NOB+1
 346   NEXT=NUSE+1
C THE LOOP THRU 348 RESETS THE SEARCH POINT, IBASE, IN THE ARRAYS IFR
C AND JFR.
       DO 348 IL=1,NTOT
       IF(IUSE(IL) NE NOB)GO TO 348
       NEXT=NEXT-1
       IF(NEXT NE 0)GO TO 348
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      IBASE=IL
      GO TO 192
  348 CONTINUE
C CONTROL WILL REACH THIS WRITE STMT ONLY IF AN ERROR OCCURS IN THE
C SCANNING PROCESS. PERTINENT WORKING VARIABLES ARE PRINTED AND THE PGM
C IS STOPPED.
      WRITE(6,349)
  349 FORMAT(/10X,47HERROR--DETERMINATION OF ELEMENTS COMPOSING FIRE)
      WRITE(6,3490)I,II,JJ,IT1,IT2,ISAVE,NEXT,NSQ,NOP,NOB,NBTOT,NUSE,
     1             NBASE,NFOUND,ICTR,IBASE,NTOT,IL
 3490 FORMAT(//5X,18I5)
      IF(NTOT.LE.0) STOP
      WRITE(6,3491)(IFR(NJ),JFR(NJ),IUSE(NJ),NJ=1,NTOT)
 3491 FORMAT(/5X,3I5)
      STOP
C THE NEXT 18 STMTS DEFINE THE MAXIMUM AND MINIMUM I AND J INDICES FOR
C THE FIRE BASE JUST DISCOVERED AND ELIMINATE THE ELEMENTS OF THIS BASE
C FROM THE IFR AND JFR ARRAYS
  350 ISET=0
      IVMN=999
      JVMN=999
      IVMX=-1
      JVMX=-1
      DO 360 IL=1,NTOT
      IF(IUSE(IL).NE.0) GO TO 355
      ISET=ISET+1
      IFR(ISET)=IFR(IL)
      JFR(ISET)=JFR(IL)
      IUSE(ISET)=IUSE(IL)
      GO TO 360
  355 IF(IFR(IL).LT.IVMN) IVMN=IFR(IL)
      IF(JFR(IL).LT.JVMN) JVMN=JFR(IL)
      IF(IFR(IL).GT.IVMX) IVMX=IFR(IL)
      IF(JFR(IL).GT.JVMX) JVMX=JFR(IL)
  360 CONTINUE
C NTOT IS NOW RESET TO THE NUMBER OF FLAMING ELMNTS REMAINING ON THIS
C SURFACE OR GROUP OF SURFACES THAT HAVE NOT AS YET BEEN ORGANIZED INTO
C A FIRE BASE.
      NTOT=ISET
C FOR SEATS NO RE-SCANNING WILL BE REQUIRED.
      IF(I.GT.LSN)GO TO 480
C SET THE FLAG ISAVE = 1 IF RE-SCANNING FOR ADDITIONAL FIRES WILL BE
C REQUIRED.
      ISAVE=1
      IF(ISET.EQ.0) ISAVE=0
C INCREASE THE NUMBER OF FIRES BY ONE AND SAVE THE I AND J LIMITS.  IF
C THIS IS A FIRE ON A SEAT ISFIRE(K) WILL BE CHANGED LATER.
  480 K=K+1
      ISFIRE(K)=0
      IVMIN(K)=IVMN
      IVMAX(K)=IVMX
      JVMIN(K)=JVMN
      JVMAX(K)=JVMX
      XNSQ=NSQ
C COMPUTE FIRE BASE AREA.
      AF(K)=SQD*SQD*XNSQ
C COMPUTE FIRE BASE HYDRAULIC RADIUS.
      YZ(K)=2.0*AF(K)/PERIM
C THE NEXT 26 STMTS COMPUTE THE DISPLACEMENT OF THE FIRE BASE CENTER
C FROM THE FLOOR, ZB(K).
      IF(I.GT.LSN) GO TO 489
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C
      IF(VN(I,1).NE.0.)GO TO 485
C FOR HORIZONTAL LINING SURFACES ZB = Z, THE SURFACE DISPLACEMENT
      ZB(K)=Z(I)
      GO TO 493
C FOR VERTICAL LINING SURFACES THE MAX AND MIN I VALUES ARE USED TO
C FIND THE VERTICAL EXTENT OF THE FIRE
 485  KX=IVMIN(K)
      IF(VN(I,1).LT.0.) KX=IVMAX(K)
      ICRIT=IRAY(KX)
      FMIN=XMN(ICRIT)
      IF(VN(I,1).LT.0.) GO TO 487
      DIF=IVMIN(K)-IMIN(ICRIT)
      GO TO 488
 487  DIF=IMAX(ICRIT)-IVMAX(K)
 488  DIF=DIF/2.0
      FMIN=FMIN+DIF
      DIF=FLOAT(IVMAX(K)-IVMIN(K))/4.0
      ZB(K)=FMIN+DIF
      GO TO 493
C FOR SEAT GROUPS ZB IS COMPUTED FROM A WEIGHTED AVERAGE OF THE NUMBER
C OF BURNING ELMNTS ON EACH OF THE 7 SEAT SURFACES. WEIGHTING FACTORS
C ARE THE DISTANCES FROM THE FLOOR TO THE CENTER OF EACH SEAT SURFACE.
 489  DO 490 KJ=1,7
 490  TEMJ(KJ)=NSFL(KJ)
      SUM=0.
       DO 491 KJ=1,7
 491  SUM=SUM+TEMJ(KJ)
      ZB(K)=(TEMJ(1)+2.*TEMJ(2)+3.75*TEMJ(3)+4.5*TEMJ(4)+3.*TEMJ(5)+1.5*
     1TEMJ(6)+1.25*TEMJ(7))/SUM
      IF(ZB(K).LT.1.0) ZB(K)=1.0
      IF(ZB(K).GT.4.5) ZB(K)=4.5
C BASED ON THE VALUES OF ZB AND THE UPPER ZONE THICKNESS XL, DETERMINE
C IF THE FIRE OCCUPIES THE UPPER ZONE, IZONE(K)=2, OR THE LOWER ZONE,
C IZONE(K)=1.
 493  ZO=ZD(IFRCMP)
      IZONE(K)=2
      IF(ZB(K).LT.ZO) IZONE(K)=1
C FOR SEATS, SET THE ARRAY ISFIRE, AND THE COUNTERS FSN1, FSN2, AND FSN3
      IF(I.LE.LSN) GO TO 500
      ISFIRE(K)=I-LSN
      FSN1=NSFL(1)
      FSN2=NSFL(6)+NSFL(7)
      FSN3=NSFL(2)+NSFL(3)+NSFL(4)+NSFL(5)
C PREPARE TO COMPUTE THE FLAME LENGTH AND OTHER FLAME PROPERTIES
C DEPENDENT UPON THE MATERIAL BURNING BY SELECTING THE NUMBER, M, OF
C THE MATERIAL.
 500  IF(ISFIRE(K).NE.0) GO TO 510
      II=IVMIN(K)
      IX=IRAY(II)
      M=IMATL(IX)
      GO TO 585
 510  JJ=JVMIN(K)
      IX=IRAYS(JJ)
      M=IMATS(IX)
 585  CONTINUE
C FOR THE SPECIAL CASE OF THE IGNITION SOURCE FIRE THE COMBUSTION
C QUANTITIES QCMB THRU RADFIR ARE COMPUTED AS WEIGHTED AVERAGES OF THE
C SAME QUANTITIES FOR THE IGN SRC FUEL AND FOR THE MATL ON WHICH THE
C FUEL LIES. THE WEIGHTING FACTORS ARE DETERMINED FROM THE RATIOS OF
C THE IGN SRC FUEL AREA, AFI, AND THE TOTAL BASE AREA OF THE FIRE
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C INVOLVING THE IGN SRC FUEL, AF(K)
      IF(IBURN.EQ.0) GO TO 589
      IF(I.NE.IGSN) GO TO 589
      IF(IGMNI.LT.IVMIN(K)  .OR.  IGMXI.GT.IVMAX(K)) GO TO 589
      IF(IGMNJ.LT.JVMIN(K)  .OR.  IGMXJ.GT.JVMAX(K)) GO TO 589
      AEXP=AF(K)-AFI
      IF(AEXP.LE.0.0) GO TO 589
      RA1=AFI/AF(K)
      RA2=AEXP/AF(K)
 587  QCMB(K)=QCI*RA1+QTAB(M)*RA2
      GAMMA(K)=GAMI*RA1+GTAB(M)*RA2
      RHOZ(K)=RHOI*RA1+RTAB(M)*RA2
      UZ(K)=XMUI*RA1+UTAB(M)*RA2
      RADFIR(K)=RADI*RA1+RADTAB(M)*RA2
      QCMB(K)=QCMB(K)*(1.-RADFIR(K))
      GO TO 600
 589  RA1=0.
      RA2=1.
      GO TO 587
C PREPARE TO COMPUTE THE FLAME LENGTH BY SELECTING THE APPROPRIATE
C EXTERIOR (TO THE FLAMES) GAS DENSITY AND TEMPERATURE BASED ON WHICH
C ZONE THE FIRE BASE CENTER OCCUPIES.
 600  IF(IZONE(K).EQ.2) GO TO 610
      RR=RHOL(IFRCMP)
      TT=TL(IFRCMP)
      YO2 = CHIL(2,IFRCMP)
      GO TO 620
 610  RR=RHOU(IFRCMP)
      TT=TU(IFRCMP)
      YO2 = CHIU(2,IFRCMP)
C THE NEXT 10 STMTS COMPUTE THE FLAME LENGTH  SEE EQ 5-14 OF [1].
 620  OMEGA(K)=1./(1.+(YO2*QCMB(K))/(GAMMA(K)*CP*TT))
      R=RR/RHOZ(K)
      X=OMEGA(K)*R+GAMMA(K)/YO2
      TEMP=(OMEGA(K)/(1.-OMEGA(K))*X/(0.0081)*X)**0.2
      TEMP=YZ(K)*TEMP*((UZ(K)/(R*SQRT(GRAV*YZ(K))))**0.4)
      TEMP1=R-1.+GAMMA(K)/YO2*((1.-OMEGA(K))/OMEGA(K))
      TEMP1=(2.25*TEMP1+1.6-R)**3
      TEMP2=X**3*(1.-OMEGA(K)*(1.+GAMMA(K)/YO2)/X)*1.95
      FKA=( 2.0736 *(1.-OMEGA(K)))*TEMP1/TEMP2
      FLML(K)=(1.49+0.916*(FKA**0.2))*TEMP
C IF THE FLAME LENGTH IS GREATER THAN THE CEILING HEIGHT SET IT TO CH.
      IF(FLML(K).GT.CH) FLML(K)=CH
C COMPUTE THE COMBUSTION ZONE LENGTH.  SEE EQ 5-6 OF [1].  IF COMB IS
C GREATER THAN THE CEILING HEIGHT SET IT TO CH.
      COMB(K)=1.49*TEMP
      IF(COMB(K).GT.CH) COMB(K)=CH
C THE NEXT 5 STMTS COMPUTE THE EMITTANCE AT THE FLAME BASE CENTER
C SEE EQ 2-4 OF [2].
      AFTR=-1.8*ABSCF(K)
      EXP1=1.-EXP(AFTR*FLML(K))
      EXP2=1.-EXP(AFTR*YZ(K))
      EXP3=1.-EXP(AFTR*SQRT(FLML(K)*FLML(K)+YZ(K)*YZ(K)))
      ALPC=EXP1+EXP2-EXP3
C THE REMAINING STMTS OF THE SUBROUTINE COMPUTE THE SMOLDERING RANGE,
C PDH, SEE SECTION 4.2.3 OF [1].
      ALP=0.5*ALPC
      QPR=QP(M)-(QC(1)+QC(2))/2.
      P=((ALP*FLML(K)*FLML(K))/(ALPC*PI*YZ(K)))-YZ(K)
      SZZ=ALP*YZ(K)*FLML(K)*FLML(K)/PI
      SZZ=SZZ*((1./ALPC)-(EB/QPR))
```

```
      GAM=-P/3.
      AA=-P*P/3.
      BB=(2.*P*P*P+27.*SZZ)/27.
      TEMP=BB*BB/4.+AA*AA/27.*AA
      IF(TEMP) 630,640,650
630   T1=SQRT(-AA*AA*AA/27.)
      T2=-BB/(2.*T1)
      IF(T2.LT.-1.) T2=-1.
      IF(T2.GT.1.) T2=1.
      ANG=ACOS(T2)
      T4=2.*SQRT(-AA/3.)
      X1=T4*COS(ANG/3.)+GAM
      X2=GAM+T4*COS((ANG+2.*PI)/3.)
      X3=GAM+T4*COS((ANG+4.*PI)/3.)
      GO TO 645
640   T1=(ABS(BB)/2.)**0.333333
      IF(BB.GT.0.) T1=-T1
      X1=2.*T1+GAM
      X2=GAM-T1
      X3=-999.
645   PDH=X1
      IF(X2.GT.PDH) PDH=X2
      IF(X3.GT.PDH) PDH=X3
      PDH=PDH-YZ(K)
      GO TO 700
650   T1=-BB/2.
      T2=SQRT(TEMP)
      F1=(ABS(T1+T2))**0.333333
      IF((T1+T2).LT.0.) F1=-F1
      F2=0.
      IF(T1.EQ.T2) GO TO 660
      F2=(ABS(T1-T2))**0.333333
      IF((T1-T2).LT.0.) F2=-F2
660   PDH=F1+F2+GAM-YZ(K)
700   RETURN
      END
```

```
      SUBROUTINE RATES(I)
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) COMPUTE RATES OF FLAME SPREAD; RATES OF HEAT, SMOKE, AND GAS
C     RELEASE, TIMES TO IGNITE, BURN OUT, BEGIN TO SMOLDER, EXTINGUISH
C     FROM SMLDRG; AND THE SMLDRG LAG TIME FOR THE CURRENT FIRE, K, ON
C     SURFACE I
C (2) COMPUTE LOCAL FLAME RADIATION LEVELS FOR THE CURRENT FIRE: Q1,Q2.
C     THESE LEVELS ARE USED TO FIND THE RATES AND TIMES IN (1) ABOVE.
C (3) COMPUTE THE FLAME ABSORPTION COEFFICIENT FOR THE CURRENT FIRE
C     USING THE NEWLY DETERMINED VALUE OF THE RATE OF SMOKE RELEASE.
C     THIS ABSORPTION COEFF. WILL CARRY OVER TO THE NEXT PASS THRU THE
C     FLAME SPREAD CALCULATIONS TO COMPUTE Q1 AND Q2.
C COMMENTS
C (1) DUE TO THE POSSIBILITY OF THE CURRENT FIRE, K, SPREADING TO NEW
C     SURFACES OF DIFFERENT MATERIALS, RATES COMPUTES THE RADIATION
C     CONTROLLED QUANTITIES FUR ALL CABIN SURFACES USING THE CURRENT
C     FIRE'S LOCAL RADIATION AND THE UPPER ZONE GAS RADIATION.
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120,15), ISTATS(9,16,22),
     1             IWORD(120,15), IWORDS(9,16,22), NFLM(7), NPYR(7),
     2             RGS(10,7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2,100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20,4), RFS(7,4),
     1             RFWS, RGF(10,7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDQ,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11,5), CHIU(11,5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40,15), IARY(40,12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9,10), ISSWLJ(9,10), ISSWRI(9,10), ISSWRJ(9,10),
     5             ISWSL(15,8), ISWSR(15,8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20,3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6), TABY(18,7,6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30,2,4), TSP(2,2,4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
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```
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
      DIMENSION QB(20),QBS(7)
C Q1     = LOCAL FLAME RADIATION INTENSITY AT THE EDGE OF THE FLAME BASE
C          (FLAME FOOT) IN BTU/(FT*FT*SEC).
C Q2     = LOCAL FLAME RADIATION INTENSITY OVER FLAME BASE (AVERAGE
C          VALUE) IN BTU/(FT*FT*SEC).
C ALPC, THE FLAME EMITTANCE FOR THIS FIRE, WAS JUST FOUND IN SUBR. SCAN
      Q1=ALPC*EB/2.
      Q2=0.84*EB*ALPC
C IRET IS A FLAG TO INDICATE WHETHER THE SURFACE UNDER CONSIDERATION IN
C THE LOOP BELOW IS A LINING (IRET = 0) OR A SEAT SURFACE (IRET = 1).
      IRET=0
C ZZ IS THE DISTANCE FROM THE CABIN FLOOR TO THE BOTTOM OF THE UPR ZONE
      ZZ = ZD(IFRCMP)
C QB     = ARRAY CONTAINING THE RADIATION INTENSITY DUE TO UPPER ZONE GAS
C            RADIATION AT EACH LINING SURFACE, SUBSCRIPT IS SURF NUMBER
C QBS    = ARRAY CONTAINING THE RADIATION INTENSITY DUE TO UPPER ZONE GAS
C            RADIATION AT EACH SEAT SURFACE. SUBSCRIPT IS SURF NUMBER.
C            QBS IS ASSUMED TO BE THE SAME FOR THE CORRESPONDING SURFACE
C            ON ALL SEAT GROUPS.
C INITIALIZE QB(1) TO QC(1), THE GAS-TO-LOWER-ZONE-SURFACES RADIATION
C FLUX COMPUTED DURING THE LAST PASS IN ATMOS. IF THE UPPER ZONE HAS
C REACHED THE FLOOR, SET QB(1) TO QC(2), THE GAS-TO-UPPER-ZONE-SURFACES
C FLUX LAST COMPUTED IN ATMOS.  ON THE FIRST FLAME SPREAD PASS QC(1)=
C QC(2) = 0.
      QB(1)=QC(1)
      IF(-ZZ.LE.0.) QB(1)=QC(2)
C ICT IS A SWITCH USED TO DIFFERENTIATE BETWEEN LINING AND SEAT SURFACES
C AND TO SELECT AMONG SEAT SURFACES. ICT=1 => LINING SURFS.
      ICT=1
C START OF A LOOP OF ALL CABIN LINING SURFS, L = SURFACE NUMBER
      L=1
 10   L=L+1
      IF(L.GT.LSN)GO TO 180
C DETERMINE THE POSITION OF THE ZONE INTERFACE, ZZ, WITH RESPECT TO THE
C MAXIMUM, XMX, AND MINIMUM, XMN, HEIGHTS OF A SURFACE ABOVE THE FLOOR
C AND APPORTION THE FLUX LEVELS QC(1) AND QC(2) ACCORDINGLY BY LINEAR
C INTERPOLATION.
 100  IF(XMX(L) .LT. ZZ ) GO TO 110
      IF(XMN(L) .GT. ZZ ) GO TO 120
      TEMP = 0.
      D = XMX(L) - XMN(L)
      IF( D .LE. 0. ) GO TO 120
      TEMP = ((ZZ-XMN(L))*QC(1) + (XMX(L)-ZZ)*QC(2)) / D
      GO TO 130
 110  TEMP = QC(1)
      GO TO 130
 120  TEMP = QC(2)
 130  CONTINUE
C USE FLAG IRET TO ASSIGN THE FLUX LEVEL TO THE ARRAY FOR LINING SURFS,
C QB, OR FOR SEATS, QBS. SUBSCR II FOR QBS WILL HAVE BEEN SET WHEN
C CONTROL REACHES STMT 160, SEE BELOW.
 150  IF(IRET.EQ.1)GO TO 160
      QB(L)=TEMP
      GO TO 170
 160  QBS(II)=TEMP
C LOOP BACK TO STMT 10 IF NOT ALL LINING SURFS HAVE BEEN CONSIDERED
C (ICT=1). FOR ICT = 2,3, OR 4 SKIP TO STMTS DEFINING XMX AND XMN FOR
C SEAT SURFACES FROM WHERE CONTROL RETURNS TO STMT 100 FOR FLUX
C ASSIGNMENT  FOR ICT = 5 SKIP TO 200 TO START PROPERTY DETERMINATIONS.
C NOTE: STMTS SETTING XMX AND XMN FOR SEATS SHOULD BE MOVED TO SUBR
```

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C        INIT2 IN ANY FUTURE UPGRADE.
 170  GO TO(10,70,80,90,200), ICT
C CONTROL REACHES THIS SECTION AFTER LINING SURFS HAVE BEEN EXAMINED.
C NOW THE 7 SEAT SURFACES WILL BE ASSIGNED FLUX LEVELS, QBS, DEPENDING
C UPON WHICH ZONE THEY OCCUPY. SEE REFS. FOR SEAT SURFACE NUMBERING.
 180  QBS(1)=QC(1)
      XL = CH - ZZ
C IF THE UPPER ZONE COVERS ALL OF THE SEATS USE UPPER ZONE FLUX LEVEL
      IF(XL.GT.HT3) QBS(1)=QC(2)
C TEST TO SEE IF ANY PART OF THE SEATS IS IN THE UPPER ZONE.
      IF(XL.GT.HT1) GO TO 50
C ALL THE SEATS ARE IN THE LOWER ZONE.
      QBS(4)=QC(1)
      GO TO 60
C AT LEAST THE BACKREST TOPS ARE IN THE UPPER ZONE.
 50   QBS(4)=QC(2)
C TEST TO SEE IF THE SEAT CUSHION TOPS ARE IN THE UPPER ZONE.
 60   QBS(6)=QC(1)
      IF(XL.GT.HT2) QBS(6)=QC(2)
C LOWER SEAT BACK REAR SURFACE (SEAT SURF 2)
      IRET=1
      ICT=2
      II=2
      XMX(L)=3.0
      XMN(L)=1.0
      GO TO 100
C UPPER SEAT BACK REAR SURFACE (SEAT SURF 3)
 70   ICT=3
      II=3
      XMX(L)=4.5
      XMN(L)=3.0
      GO TO 100
C SEAT BACK FRONT SURFACE (SEAT SURF 5)
 80   ICT=4
      II=5
      XMX(L)=4.5
      XMN(L)=1.5
      GO TO 100
C SEAT CUSHION FRONT SURFACE (SEAT SURF 7)
 90   ICT=5
      II=7
      XMX(L)=1.5
      XMN(L)=1.0
      GO TO 100
C START OF A LOOP OVER ALL LINING SURFACES TO FIND FLAME SPREAD RATES
C AND IGNITION, BURN OUT, AND SMOLDERING LAG TIMES.
 200  DO 210 L=1,LSN
C QT= GAS ZONE RADIATION (QB) + FLAME FOOT RADIATION (Q1), THIS IS THE
C NUMBER USED TO INTERPOLATE IN THE MATERIALS PROPERTY TABLES.
      QT=QB(L)+Q1
C SELECT MATERIAL TYPE OF THIS SURFACE
      M=IMATL(L)
C USE SUBR LINT TO INTERPOLATE FOR THE VALUES OF HORIZONTAL FLAME SPREAD
C RATE, RH (FT/SEC), UPWARD FLAME SPREAD, RU (FT/SEC), AND DOWNWARD
C FLAME SPREAD RATE, RD (FT/SEC). INTEGERS ARE DATA TABLE NUMBERS
      CALL LINT(1,QT,M,RH)
      CALL LINT(2,QT,M,RU)
      CALL LINT(3,QT,M,RDWN)
      IF(I.NE.L)GO TO 201
C ASSIGN FLAME SPREAD RATES TO THIS SURFACE (L) ACCORDING TO ITS ORIEN-
C TATION AS DETERMINED BY THE NORMAL VECTOR, VN
```

```
 201  RF(L,1)=RH
      RF(L,2)=RH
      IF(VN(L,3).EQ.0.) GO TO 202
      RF(L,3)=RH
      RF(L,4)=RH
      GO TO 206
 202  IF(VN(L,1).LT.0.) GO TO 204
      RF(L,3)=RDWN
      RF(L,4)=RU
      GO TO 206
 204  RF(L,3)=RU
      RF(L,4)=RDWN
C QT = GAS ZONE RADIATION (QB) + AVERAGE FLAME BASE RADIATION (Q2)
C USE LINT TO INTERPOLATE FOR TIME TO IGNITE, ITF, SMLDRG LAG TIME,
C ITPE, AND TIME TO BURN OUT, ITFC. ALL VALUES ARE IN INTEGER SECONDS.
 206  QT=QB(L)+Q2
      CALL LINT(4,QT,M,X)
      ITF(L)=X+0.5
      CALL LINT(7,QT,M,X)
      ITPE(L)=X+0.5
      CALL LINT(8,QT,M,X)
      ITFC(L)=X+0.5
C END OF THE LINING SURFACE LOOP
 210  CONTINUE
C START OF A LOOP OVER THE 7 SEAT SURFACES TO FIND FLAME SPREAD RATES,
C AND IGNITION, BURN OUT, AND SMOLDERING LAG TIMES.
      DO 220 L=1,7
C QT = GAS ZONE RADIATION (QBS) + FLAME FOOT RADIATION (Q1)
      QT=QBS(L)+Q1
C SELECT MATERIAL TYPE FOR THIS SEAT SURFACE.
      M=IMATS(L)
C FIND HORIZONTAL, UPWARD, AND DOWNWARD FLAME SPREAD RATES, SYMBOLS AND
C UNITS AS ABOVE FOR LINING SURFACES.
      CALL LINT(1,QT,M,RH)
      CALL LINT(2,QT,M,RU)
      CALL LINT(3,QT,M,RDWN)
      IF(I.LE.LSN)GO TO 2100
 2100 RFS(L,3)=RH
      RFS(L,4)=RH
C SELECT AMONG THE 7 SEAT SURFACES TO ASSIGN FLAME SPREAD RATES BY
C SURFACE ORIENTATION. N=L=SURFACE NUMBER.
      N=L
      GO TO (211,212,212,211,214,211,214),N
 211  RFS(L,1)=RH
      RFS(L,2)=RH
      GO TO 216
 212  RFS(L,1)=RDWN
      RFS(L,2)=RU
      GO TO 216
 214  RFS(L,1)=RU
      RFS(L,2)=RDWN
C QT = GAS ZONE RADIATION (QBS) + AVERAGE FLAME BASE RADIATION (Q2)
C INTERPOLATE FOR IGNITION, BURN OUT, AND SMLDRG LAG TIMES AS ABOVE.
 216  QT=QBS(L)+Q2
      CALL LINT(4,QT,M,X)
      ITFS(L)=X+0.5
      CALL LINT(7,QT,M,X)
      ITPES(L)=X+0.5
      CALL LINT(8,QT,M,X)
      ITFCS(L)=X+0.5
C END OF THE SEAT SURFACE LOOP
```

```
 220  CONTINUE
C FOLLOWING LOOP IS FOR FINDING THE RATES OF HEAT, SMOKE, AND GAS
C EMISSION. NOTE THAT UNLIKE THE FLAME SPREAD RATES AND IGNITION, ECT.
C TIMES FOUND ABOVE, THE LOOP IS OVER ALL MATL TYPES SINCE NO QUANTITIES
C INVOLVING STATE CHANGES ARE INVOLVED
      DO 230 M=1,NMATLS
C DETERMINE IF THIS SURF,I, IS A SEAT OR LINING SURFACE AND ASSIGN TOTAL
C FLUX LEVELS AS REQUIRED. QT = GAS  FLUX + AVG FLAME BASE FLUX.
      IF(I.GT.LSN) GO TO 221
      QT=QB(I)+Q2
      GO TO 222
 221   QT=QBS(I)+Q2
 222  CONTINUE
C INTERPOLATE FOR HEAT RELEASE, DQM (BTU/(FT*FT*SEC)); SMOKE RELEASE,
C RSF (PART/(FT*FT*SEC)); AND GAS RELEASE, RGF (LBM/(FT*FT*SEC)) RATES
C USING QT. VALUES ARE FOUND FOR ALL MATL TYPES
C SINCE THE MATL TYPES WHICH WILL BE INVOLVED IN NEW IGNITIONS BY THIS
C FIRE ARE UNKNOWN AT THIS POINT IN THE PGM. VALUES ARE STORED IN THE
C ARRAYS DQM,RSF, AND RGF WHICH ARE SUBCRIPTED BY MATL TYPE.
      CALL LINT(5,QT,M,DQM(M))
      CALL  LINT(6,QT,M,RSF(M))
      NO=8
      DO 225 IG=1,NTXG
      NO=NO+1
      CALL LINT(NO,QT,M,RGF(IG,M))
 225  CONTINUE
 230  CONTINUE
C THE NEXT 38 STMTS (THRU 460) COMPUTE THE TOTAL RATES OF HEAT, SMOKE,
C AND GAS EMISSION, AND OXYGEN CONSUMPTION FOR THE CURRENT FIRE, K, JUST
C ISOLATED BY SUBR SCAN. THESE VALUES ARE STORED IN
C       DQK = RATE OF HEAT EMISSION (BTU/SEC)
C       RSFK = RATE OF SMOKE EMISSION (PARTICLES/SEC)
C       VITNR = RATE OF OXYGEN CONSUMPTION (LBM/SEC)
C       RGFK(IG) = RATE OF EMISSION OF THE GAS SPECIE IG (LBM/SEC)
C SINCE SUMMATION IS INVOLVED, FIRST INITIALIZE THE VARIABLES.
      SA=SQD*SQD
      DQK=0.
      RSFK=0.
      VITNR=0.
      DO 315 IG=1,NTXG
 315  RGFK(IG)=0.
C DETERMINE THE MAXIMUM AND MINIMUM I AND J INDICES  FOR THE ELMTS
C COMPOSING THIS FIRE.
      I1=IVMIN(K)
      I2=IVMAX(K)
      J1=JVMIN(K)
      J2=JVMAX(K)
C SEARCH THIS AREA DEFINED BY THE MAX AND MIN I AND J'S TO FIND THE
C ACTUAL BURNING ELMNTS
      DO 460 II=I1,I2
      DO 450 JJ=J1,J2
      CALL CVOUT(II,JJ,I,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP .OR. IST.NE.3) GO TO 450
C IGNITION SOURCE ELMNTS WILL NEED SPECIAL TREATMENT SO SKIP THE TEST
C FOR IGN SRC ELMNTS IF THE CURRENT SURF IS NOT THE IGN SRC SURFACE.
      IF(I.NE.IGSN) GO TO 420
C TEST TO FIND IF THIS ELMNT (II,JJ) IS AN IGN SRC ELMNT, IF SO SKIP TO
C STMT 445 TO INCLUDE THE EFFECTS OF THE IGN SRC FUEL IN THE HEAT, SMOKE
C AND GAS RELEASE.
      DO 410 KJ=1,NIJSG
      IF(II.EQ.IGNIJ(1,KJ).AND.JJ.EQ.IGNIJ(2,KJ))GO TO 445
```

```
 410  CONTINUE
C TEST TO SEE IF THIS NON-IGN SRC ELMNT IS A SEAT OR LINING SURF ELMNT.
 420  IF(I.GT.LSN) GO TO 430
C SELECT THE MATERIAL TYPE FOR THIS SURFACE AND STORE IN KTEMP
      KX=IRAY(II)
      KTEMP=IMATL(KX)
      GO TO 435
 430  IS=I-LSN
C SELECT THE MATERIAL TYPE FOR THIS SURFACE AND STORE IN KTEMP.
      KX=IRAYS(JJ)
      KTEMP=IMATS(KX)
C COMPUTE THE TOTAL RATES OF RELEASE AND OXYGEN CONSUMPTION.
 435  DGK=DGK+SA*DGM(KTEMP)
      RSFK=RSFK+SA*RSF(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + SA * DGM(KTEMP)
      VITNR=VITNR+SA*DGM(KTEMP)/FOX(KTEMP)
      DO 440 IG=1,NTXG
 440  RGFK(IG)=RGFK(IG)+SA*RGF(IG,KTEMP)
      GO TO 450
C COMPUTE THE TOTAL RATES OF RELEASE AND OXYGEN CONSUMPTION FOR THIS
C FIRE WHICH INVOLVES IGN SRC FUEL.
 445  DGK=DGK+SA*DGI
      RSFK=RSFK+SA*RSI
      VITNR=VITNR+SA*DGI/FOXI
      DO 447 IG=1,NTXG
 447  RGFK(IG)=RGFK(IG)+SA*RTGI(IG)
 450  CONTINUE
 460  CONTINUE
C COMPUTE THE FLAME ABSORPTION COEFFICIENT, ABSCF, FOR THIS FIRE K USING
C THE CURRENT RATE OF SMOKE RELEASE. UNITS OF ABSCF ARE 1/FT. SEE APNDX
C D OF [2].
      ABSCF(K)=0.21*RSFK/(SQRT(FLML(K)*GRAV)*AF(K))
C PROVIDE A DEFAULT VALUE OF 0.25 1/FT FOR ABSCF.
      IF(ABSCF(K).LE.0.) ABSCF(K)=0.25
      RETURN
      END
```

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      SUBROUTINE COND(I)
C --------------------------------------------------------------------
C OBJECTIVE(S)
C (1) COMPUTE FLAME SPREAD TO ELEMENTS ADJACENT TO BURNING ELEMENTS ON
C     CABIN LINING SURFACE SPECIFIED BY THE VALUE OF THE ARGUMENT I.
C (2) WHEN THE LINING SURFACE IS A SIDEWALL NEXT TO A SEAT GROUP FLAME
C     SPREAD IS COMPUTED FROM THE SIDEWALL TO THE SEAT.
C COMMENTS
C (1) SIDEWALL TO SEAT SPREAD MECHANISM IS MODELED VERY APPROXIMATELY BY
C     COMPUTING A TIME TO SPREAD, TIMWS, FROM THE VALUES OF A SPREAD
C     VELOCITY, RFWS, AND A DISTANCE, DWS, GIVEN IN THE INPUT. THIS
C     MODEL SHOULD BE REPLACED WHEN A BETTER UNDERSTANDING OF THIS
C     PROCESS IS OBTAINED.
C (2) VALUES OF THE VARIABLES IVMN, JVMN, IVMX, JVMX, ISTART, JSTART,
C     IEND, JEND, AND THE ARRAYS RF, DGM, RSF, RGF, AND ITFC HAVE JUST
C     BEEN SET FOR THE CURRENT FIRE K BY SUBROUTINES SCAN AND RATES
C     ABOVE. EACH TIME A FIRE IS ISOLATED THESE VALUES WILL CHANGE BASED
C     ON THE FIRE SIZE, RADIATION, AND SURFACE MATERIAL.
C --------------------------------------------------------------------
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1             IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2             RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3             TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4             ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5             FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6             IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7             IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8             JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9             NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1             RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2             TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3             FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4             TP(7),TPC(7)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1             RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2             VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DGI,DGM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
     5             XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6             WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
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      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
      DIMENSION ISD(4)
C II AND JJ ARE ELMNT INDICES TO BE USED IN THE SEARCH PROCEDURE
C INITIALIZE THEM USING THE MINIMUM I VALUE, IVMIN, AND MINIMUM J VALUE,
C JVMIN, FOR THE CURRENT FIRE.
      II=IVMN-1
      JJ=JVMN-1
C ICON, A CONVERSION FACTOR, IS COMPUTED USING THE MINIMUM AND MAXIMUM
C I INDEX VALUES, ISTART AND IEND, FOR THE CURRENT SURFACE (SURFACE NUM-
C BER  I).  ISTART, IEND, JSTART, AND JEND ARE SET IN SUBR FIRE AND WILL
C STAY CONSTANT AS LONG AS THE CURRENT SURFACE NUMBER, I, REMAINS SO.
      ICON=IEND-ISTART+1
C STMT 10 IS THE START OF THE MAIN LOOP OVER THE ELMNT INDEX II.  THIS
C LOOP TERMINATES AFTER STMT 170.
 10   II=II+1
C USE ARRAY IRAY TO FIND THE SURFACE NUMBER, KK, ON WHICH ELMNT ROW II
C IS LOCATED (NOT NECESSARILY SURFACE I)
      KK=IRAY(II)
C STMT 20 IS THE MAIN LOOP OVER ELMNT INDEX JJ, ENDING AFTER STMT 170.
 20   JJ=JJ+1
C COMPUTE THE INDEX OF ARRAY IF WHICH CORRESPONDS TO THE ELMNT II,JJ.
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
C USE ARRAY IF AND SUBR ISIDE TO FIND IF ELMNT II,JJ IS PART OF AND ON
C THE EDGE OF A FIRE.
 28   IF(IF(IJ).LE.1) GO TO 170
      CALL ISIDE(IF(IJ),ISD)
C USE SUBR CWORD TO UNPACK THE TIME-IN-STATE CLOCK, ITX, FOR ELMNT II,JJ
      CALL CWORD(IWORD(II,JJ),ITX,ITY)
      TXO=ITX
C L WILL BE USED AS A DIRECTION INDICATOR
      L=1
C STMT 30 STARTS A LOOP THRU STMT 100 FOR COMPUTING THE SPREAD, IF ANY,
C IN EACH OF THE FOUR DIRECTIONS AROUND ELMNT II,JJ.  TEST FOR A ZERO
C VALUE OF THE CURRENT FLAME SPREAD RATE (ON THE SURF KK) IN THE
C DIRECTION L.  L=1 => DECREASING J DIRECTION, L=2 => INCREASING J
C DIRECTION, L=3 => DECREASING I, AND L=4 => INCREASING I.  THE SPREAD
C RATE ARRAY RF HAS BEEN LOADED WITH THE PROPER RATE VALUES FOR THIS
C SURFACE AND FIRE IN THE LAST PASS THRU SUBR RATES.
 30   IF(RF(KK,L).LE.0.0) GO TO 100
C IF ISD(L) = 0 THE ADJACENT ELMNT IN THE L DIRECTION IS ALSO FLAMING
C SO SKIP TO STMT 100 TO GO ON TO A NEW DIRECTION.
      IF(ISD(L).EQ.0) GO TO 100
C COMPUTE THE TIME TO SPREAD FROM ONE ELMNT CENTER TO THE NEXT FOR THE
C CURRENT SPREAD RATE.
      TIMSP=SQD/RF(KK,L)
C IF THE TOTAL TIME THAT THE ELMNT II, JJ HAS BEEN IN THE FLAMING STATE
C IS LESS THAN THE TIME TO SPREAD TO THE ADJACENT ELMNT NO SPREAD IN
C THIS DIRECTION CAN OCCUR.  THEREFORE SKIP TO STMT 100 TO LOOK AT A NEW
C DIRECTION.
      IF(TXO.LT.TIMSP) GO TO 100
C CONTROL REACHES THIS POINT WHEN SPREAD CAN OCCUR.  BRANCH ACCORDING TO
C THE CURRENT DIRECTION
      GO TO(40,50,60,70),L
C DECREASING J DIRECTION.  TEST FOR J=1 => NO SPREAD CAN OCCUR OFF OF THE
C LEADING EDGE OF THE ELMNT ARRAY.  IF J IS NOT =1 COMPUTE INDICES OF THE
C ELMNT TO WHICH FIRE MAY SPREAD.
 40   IF((JJ-1).GE.1) GO TO 45
 41   CONTINUE
      GO TO 100
 45   IDXI=II
      IDXJ=JJ-1
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      GO TO 80
C INCREASING J DIRECTION. TEST FOR SPREAD OFF THE TRAILING EDGE OF THE
C ARRAY.  COMPUTE THE INDICES OF THE ELMNT TO WHICH FIRE MAY SPREAD.
 50   IF((JJ+1).GT.JMAX(KK)) GO TO 41
      IDXI=II
      IDXJ=JJ+1
      GO TO 80
C DECREASING I DIRECTION. TEST FOR SPREAD OFF THE LEFT (LOW I) EDGE OF
C SURFACE 1. IF SO THE I INDEX OF THE ADJACENT ELMNT WILL BE THE HIGHEST
C I ON THE LEFT SIDEWALL. COMPUTE INDICES TO WHICH FIRE MAY SPREAD.
 60   IF((II-1).GE.1) GO TO 62
      IDXI=MAXELI
      GO TO 65
 62   IDXI=II-1
 65   IDXJ=JJ
      GO TO 80
C INCREASING I DIRECTION. TEST FOR SPREAD OFF THE HIGH I EDGE OF THE
C LEFT SIDEWALL AND THUS TO THE I=1 ROW ON THE FLOOR.
C COMPUTE THE ELMNT INDICES TO WHICH FIRE MAY SPREAD.
 70   IF((II+1).LE.MAXELI) GO TO 72
      IDXI=1
      GO TO 65
 72   IDXI=II+1
      GO TO 65
C USE IRAY TO DETERMINE WHICH SURFACE ON WHICH THE "CANDIDATE" ELMNT
C LIES. THEN UNPACK THE DATA ON THIS ELMNT WITH CWORD AND CVOUT.
 80   KV=IRAY(IDXI)
 82   CALL CWORD(IWORD(IDXI,IDXJ),ITX,ITY)
      CALL CVOUT(IDXI,IDXJ,KV,IST,ISTP,ITFCP)
C BASED ON THE CURRENT STATE, IST, OF THE CANDIDATE ELEMENT, EITHER
C SET IT TO FLAMING (STATE 3) AT STMT 83 OR TAKE NO ACTION BY SKIPPING
C TO STMT 100. NO ACTION IS TAKEN IF THE CANDIDATE ELEMENT IS CURRENTLY
C IN STATES 3, 4, OR 7.
      GO TO (83,83,100,100,83,83,100),IST
C THE CANDIDATE ELMNT IS IGNITED. INCREASE THE HEAT, SMOKE, AND GAS
C RELEASE RATES AND THE OXYGEN CONSUMPTION RATE. IF THE ELMNT WAS IN
C STATE 2 DECREASE THE COUNT OF SMOLDERING ELMNTS BY ONE.
 83   IF(IST.EQ.2) NPE(KV)=NPE(KV)-1
      KTEMP=IMATL(KV)
      DGK=DGK+GTR*DGM(KTEMP)
      RSFK=RSFK+GTR*RSF(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + GTR * DGM(KTEMP)
      VITNR=VITNR+GTR*DGM(KTEMP)/FOX(KTEMP)
      DO 85 IG=1,NTXG
 85   RGFK(IG)=RGFK(IG)+GTR*RGF(IG,KTEMP)
C SET THE "FRACTION CONSUMED" CLOCK, ITFCP, USING THE SPREAD CALCULATION
C INTERVAL, DELTSP, AND THE TIME-TO-BURN-OUT, XTFC. THIS SETTING IS
C THE FRACTION CONSUMED BY THE END OF THIS PASS.
      XTFC=ITFC(KV)
      IF(XTFC.LE.0.) GO TO 100
      KTEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+KTEMP
C SET THE STATE TO 3, THE TIME-IN-STATE TO ZERO MILLISECONDS, AND UP THE
C COUNT OF FLAMING ELMNTS BY ONE
 90   IST=3
      ITX=0
      NFE(KV)=NFE(KV)+1
C REPACK IWORD AND ISTATE WITH THE NEW CONDITION OF ELMNT IDXI, IDXJ
      ISG=1
      IF(ITY.LT.0) ISG=-1
      IWORD(IDXI,IDXJ)=ITY*10000+ISG*ITX
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      ISTATE(IDXI,IDXJ)=ITFCP*100+ISTP*10+IST
C IF ALL DIRECTIONS AWAY FROM ELMNT II, JJ HAVE BEEN EXAMINED SKIP TO
C 120 FOR SEAT IGNITION DETERMINATION. IF NOT, PICK NEXT DIRECTION
C AND RETURN TO TOP OF LOOP AT STMT 30.
 100  IF(L.EQ.4) GO TO 110
 109  L=L+1
      GO TO 30
C THE REMAINING PART OF THIS SUBROUTINE CALCULATES THE SPREAD TO CABIN
C SEATS THRU THEIR IGNITION BY BURNING SIDEWALL ELMNTS. THIS IS DONE
C ONLY IF THE CURRENT SURFACE I IS A SIDEWALL SURFACE.
 110  LTEMP=KK
C IF THE INPUT RATE OF SIDEWALL-TO-SEAT SPREAD IS ZERO SKIP TO END
      IF(RFWS.LE.0.) GO TO 170
C TEST IF THE CURRENT SURFACE IS A SIDEWALL AND DETERMINE IF IT IS A
C RIGHT SIDEWALL ( GO TO 130) OR A LEFT SIDEWALL (GO TO 120). IF NEITHER
C SKIP TO END.
      IF(I.GT.1 .AND. I.LT.ICLR)GO TO 130
      IF(I.GT.ICLL .AND. I.LE.LSN)GO TO 120
      GO TO 170
C LEFT SIDEWALL. USE ARRAY ISWSL TO FIND IF THE CURRENT SIDEWALL ELMNT
C II, JJ CAN IGNITE A NEARBY SEAT. A NON-ZERO VALUE OF ISWSL(JJ,1) GIVES
C THE SEAT GROUP NUMBER AND THE SPECIFIC SEAT GROUP ELMNT THAT MAY BE
C IGNITED IS GIVEN BY ISWSL(JJ,KK) WHERE KK IS FOUND FROM II.
 120  KK=ILSTL-II+2
      IF(KK.GT.8 .OR. KK.LT.1)GO TO 170
      ITEMP=ISWSL(JJ,KK)
      IF(ITEMP.EQ.0)GO TO 170
      IS=ISWSL(JJ,1)
      IP=1
      GO TO 140
C RIGHT SIDEWALL. USE ARRAY ISWSR TO FIND IF THE CURRENT SIDEWALL ELMNT
C II, JJ CAN IGNITE A NEARBY SEAT. PROCEDURE IS SAME AS FOR RT SIDEWALL
 130  KK=2+II-IFIRR
      IF(KK.GT.8 .OR. KK.LT.1)GO TO 170
      ITEMP=ISWSR(JJ,KK)
      IF(ITEMP.EQ.0)GO TO 170
      IS=ISWSR(JJ,1)
      IP=2.0*SGWD(IS)+TOL
C SEAT GROUP AND ELMNT TO BE IGNITED HAVE BEEN FOUND. PROCEED AS ABOVE
C TO COMPUTE TIME TO SPREAD AND COMPARE THAT VALUE TO THE TIME THAT
C ELMNT II, JJ HAS BEEN IN THE FLAMING STATE.
 140  JP=ITEMP
      ICRIT=LSN+IS
      IF(RFWS.LE.0.0)GO TO 165
      TIMWS=DWS/RFWS
      IF(TXO.LT.TIMWS) GO TO 165
C IF CONTROL REACHES THIS POINT THE SEAT GROUP ELMNT WHICH IS A
C CANDIDATE FOR IGNITION WILL NOW HAVE ITS STATE DATA UNPACKED.    IF
C THIS SEAT ELMNT IS NOT ALREADY IN STATES 3, 4, OR 7 IT IS IGNITED
C AND ALL THE PROPER VARIABLES ARE UPDATED AS WAS DONE ABOVE.
      CALL CWORD(IWORDS(IS,IP,JP),ITX,ITY)
      CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.EQ.3.OR.IST.EQ.4.OR.IST.EQ.7) GO TO 165
      KJ=IRAYS(JP)
      IF(IST.EQ.2) NPE(ICRIT)=NPE(ICRIT)-1
      KTEMP=IMATS(KJ)
      DGK=DGK+QTR*DGM(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + QTR * DGM(KTEMP)
      RSFK=RSFK+QTR*RSF(KTEMP)
      VITNR=VITNR+QTR*DGM(KTEMP)/FOX(KTEMP)
      DO 150 IG=1,NTXG
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 150   RGFK(IG)=RGFK(IG)+QTR*RGF(IG,KTEMP)
       XTFC=ITFCS(KJ)
       IF(XTFC.LE.0.) GO TO 165
       KTEMP=(DELTSP/XTFC)*THOU
       ITFCP=ITFCP+KTEMP
C REPACK IWORDS AND ISTATS WITH THE NEW CONDITION OF THIS SEAT ELMNT.
 160   IST=3
       ITX=0
       NFE(ICRIT)=NFE(ICRIT)+1
       ISG=1
       IF(ITY.LT.0) ISG=-1
       IWORDS(IS,IP,JP)=ITY*10000+ISG*ITX
       ISTATS(IS,IP,JP)=ITFCP*100+ISTP*10+IST
 165   CONTINUE
 170   KK=LTEMP
C END  OF THE LOOP OVER JJ
       IF(JJ.LT.JVMX) GO TO 20
       JJ=JVMN-1
C END  OF THE LOOP OVER II
       IF(II.LT.IVMX) GO TO 10
       RETURN
       END
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      SUBROUTINE FCON(I)
C ----------------------------------------------------------------------
C OBJECTIVE
C (1) THIS SUBROUTINE COMPUTES THE EXPOSURE AND IGNITION OF ELMNTS
C     THRU THE CONTACT BY FLAMES OF FIRES BURNING ON NON-ADJACENT
C     SURFACES.  SPECIFICALLY THE FOLLOWING SITUATIONS ARE CONSIDERED -
C
C       (A) FLAMES FROM A FIRE ON THE CABIN FLOOR TOUCH AND IGNITE A
C           SEAT GROUP
C       (B) FLAMES FROM A FIRE ON THE CABIN FLOOR TOUCH AND IGNITE ELMNTS
C           ON THE CEILING.
C       (C) FLAMES FROM A FIRE ON THE SIDEWALL TOUCH AND IGNITE OTHER
C           WALL ELMNTS, HATRACK ELMNTS, OR CEILING ELMNTS.
C
C COMMENTS
C (1) STATEMENT NUMBERING IN THIS SUBROUTINE IS NOT SEQUENTIAL
C (2) TERMINOLOGY  AN ELMNT OF A FIRE BASE WHOSE FLAMES MAY CONTACT
C                  SOME OTHER ELMNT IS CALLED A "SHOOTING ELMNT".
C                  THE ELMNT WHICH MAY BE IGNITED BY THE FLAME CONTACT
C                  IS CALLED THE "TARGET ELMNT."
C (3) FLAME CONTACT FROM FIRES ON THE SIDEWALLS IS LIMITED TO SHOOTING
C     ELMNTS WITHIN TWO ROWS (I INDICES) OF THE CEILING/STOW-BIN/PSU
C     SURFACES
C ----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1             IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2             RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3             TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4             ACM(7),AF(30),AFI,AEXP,COMB(30),DQK,FLML(30),FSN1,
     5             FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6             IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7             IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8             JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSG,
     9             NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1             RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDG,
     2             TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3             FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDGMTL(7),
     4             TP(7),TPC(7)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1             RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2             VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DQI,DGM(7),GAMI,GTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
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     3              ITPE(20).ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4              RHOM(7),PSI,RTAB(7),RTSI(10),UTAB(7),CNDCTY(7),XMUI,
     5              XMFI,TKNS(7),TSL(30,2,4),TSP(2,2,4),CPM(7),WMMTL(7),
     6              WMIGF,TKNSIN(7)
      COMMON/PARAMS/GRAV,PI,QTR,RGAS,SIGMA,SQD,THOU,TOL,EC,EP
      COMMON/RADTN/ALPC,ABSCF(30),EB,QC(2)
C ICOUNT IS A FLAG TO CONTROL SELECTION OF SIDEWALL SHOOTING ELMNTS
C ICNTR IS A FLAG SIGNALING REQUIREMENT FOR ADDITIONAL SEARCHING
C IHRZ IS A FLAG INDICATING THE ORIENTATION OF SURF I,
C     IHRZ = 0 => VERTICAL,   IHRZ = 1 => HORIZONTAL.
      ICOUNT=1
      ICNTR=0
      IHRZ=0
C FHGT = DISPLACEMENT OF FIRE BASE FROM FLOOR + FLAME LENGTH
      FHGT=ZB(K)+FLML(K)
C ICON IS THE CONVERSION FACTOR FOR USE WITH ARRAY IF
      ICON=IEND-ISTART+1
C STMTS 10 AND 20 START A PAIR OF NESTED LOOPS OVER THE ELMNTS WITHIN
C THE REGION DEFINED BY IVMN, JVMN, IVMX, AND JVMX.  THIS IS THE REGION
C CONTAINING THE MOST RECENTLY ISOLATED FIRE BASE FROM SUBR FIRE ABOVE.
C THE LOOPS END JUST AFTER STMT 300.
      II=IVMN-1
 10   II=II+1
      JJ=JVMN-1
 20   JJ=JJ+1
C COMPUTE THE SINGLE INDEX, IJ, OF ARRAY IF THAT CORRESPONDS TO THE
C ELMNT II, JJ.  THE VALUE OF IF(IJ) WILL TELL IF THIS ELMNT IS FLAMING
C AND THUS IS A SHOOTING ELEMENT.
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
C FIRST CONSIDER ONLY FIRES ORIGINATING ON THE CABIN FLOOR (SURF 1). IF
C THE SURFACE I (IN THE SUBR CALL) IS NOT THE FLOOR SKIP TO STMT 40 TO
C CONSIDER CASE C OF OBJECTIVE (1).
      IF(I.GT.1)GO TO 40
C FLAMES FROM THE FLOOR MAY CONTACT SEATS, HATRACK, OR CEILING/PSU/STOW
C BINS.
C FIRST TEST TO FIND IF FLAME LENGTH IS ENOUGH TO CONTACT SEATS.
      IF(FHGT.LT.Z(LSN+1))GO TO 500
C IF ELMNT II, JJ IS NOT FLAMING SKIP TO THE END OF THE LOOP TO GO ON TO
C ANOTHER ELMNT.
      IF(IF(IJ).LT.1)GO TO 300
C TEST TO FIND IF A SEAT GROUP IS ABOVE THIS ELMNT.
      IS=IARX(II,JJ)
C IF THERE IS NOT A SEAT GROUP ABOVE, SKIP TO STMT 25 TO CHECK CEILING.
      IF(IS.EQ.0)GO TO 25
C WHEN CONTROL REACHES THE NEXT STMT A SEAT IS ABOVE AND WILL BE IN
C CONTACT WITH THE FLAMES. SELECT THE INDICES OF THE SEAT SURFACE
C (CUSHION BOTTOM) ELMNT USING ARRAYS IONE AND JONE.
      ICRIT=LSN+IS
      IP=II-IONE(IS)
      JP=JJ-JONE(IS)
C USE CVOUT TO DETERMINE THE STATE OF ELMNT IP, JP.
      CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
C IF THIS ELMNT HAS JUST BEEN SET TO A NEW STATE, SKIP ANY OTHER STATE
C CHANGES.
      IF(IST.NE.ISTP)GO TO 300
C USE CWORD TO UNPACK THE CLOCKS AND FLAGS FOR THE TARGET ELMNT IP, JP
C SELECT THE CURRENTLY APPLICABLE TIME-TO-IGNITE, ITFCS.
      CALL CWORD(IWORDS(IS,IP,JP),ITX,ITY)
      KTEMP=IMATS(1)
      XTFC=ITFCS(1)
      IF(XTFC.LE.0.) GO TO 300
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      ITXX=ITFS(1)
C SKIP ANY CHANGES TO THE TARGET ELMNT'S STATE IF IT IS FLAMING, CHARRED
C OR COOLING.
 200  GO TO(258,265,300,300,260,265,300), IST
C IF THE TARGET ELMNT IS IN STATE 1 OR STATE 5 SET IT TO STATE 6 -
C HEATING IN CONTACT WITH FLAMES.
 258  ITX=0
 260  IST=6
      GO TO 290
 265  IF(IST.EQ.2)GO TO 270
C FOR TARGET ELMNTS IN STATE 6, TEST THEIR TIME-IN-STATE, ITX VS. THE
C CURRENT TIME-TO-IGNITE. IF IGNITION OCCURS RESET ITX AND SKIP TO 280
C TO COMPLETE THE STATE CHANGE.
      IF(ITX.LT.ITXX)GO TO 300
      ITX=ITX-ITXX
      GO TO 280
 270  CONTINUE
C FOR TARGET ELMNTS IN STATE 2, IGNITE THEM IN ALL CASES.
      ITX=0
      NPE(ICRIT)=NPE(ICRIT)-1
C IGNITION.  COMPUTE ADDITIONS TO SMOKE, HEAT, AND GAS GENERATION AND
C OXYGEN CONSUMPTION RATES.
 280  IST=3
      DQK=DQK+GTR*DQM(KTEMP)
      RSFK=RSFK+GTR*RSF(KTEMP)
      TDQMTL(KTEMP) = TDQMTL(KTEMP) + GTR * DQM(KTEMP)
      VITNR=VITNR+GTR*DQM(KTEMP)/FOX(KTEMP)
      DO 282 IG=1,NTXG
 282  RGFK(IG)=RGFK(IG)+GTR*RGF(IG,KTEMP)
C COMPUTE THE NEW VALUE FOR THE FRACTION CONSUMED, ITFCP, AND REPACK
C THE STATE DATA IN THE APPROPRIATE ARRAYS.
      ITEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+ITEMP
      NFE(ICRIT)=NFE(ICRIT)+1
 290  ISG=1
      IF(ITY.LT.0) ISG=-1
      IT1=ITY*10000+ISG*ITX
      IT2=ITFCP*100+ISTP*10+IST
      IF(ICRIT.GT.LSN)GO TO 295
      IWORD(IP,JP)=IT1
      ISTATE(IP,JP)=IT2
      GO TO 300
 295  IWORDS(IS,IP,JP)=IT1
      ISTATS(IS,IP,JP)=IT2
C CHECK THE FLAG ICNTR TO FIND IF MORE SIDEWALL-TO-CEILING CHECKING IS
C TO BE DONE.
 300  IF(ICNTR.NE.0)GO TO 310
C CLOSE OF THE LOOPS OVER II AND JJ.
      IF(JJ.LT.JVMX)GO TO 20
      IF(II.LT.IVMX)GO TO 10
      GO TO 500
C THE REMAINING PART OF THIS SUBR CONSIDERS FLAMES FROM UPPER SIDEWALLS
C AND HATRACK REACHING THE CEILING AND FLAMES FROM THE FLOOR REACHING
C THE HATRACK OR CEILING.
C THE NEXT 4 STMTS INCREMENT THE J INDICES OF THE SHOOTING AND TARGET
C ELMNTS WHEN THE SURFACE OF ORIGIN IS NOT THE FLOOR.
 310  IF(IHRZ.EQ.1)GO TO 340
      IF(JJ.GE.JVMX)GO TO 320
      JJ=JJ+1
      JP=JJ
      GO TO 30
```

```
C THE NEXT 6 STMTS INCREMENT THE I INDICES OF THE SHOOTING AND TARGET
C ELMNTS WHEN THE SURFACE OF ORIGIN IS NOT THE FLOOR
C ICOUNT ALLOWS ONLY NEAR-CEILING SHOOTING ELMNTS TO BE USED
 320  IF(ICOUNT.EQ.2)GO TO 500
      ICOUNT=2
      JJ=JVMN
      IT=L+INCR
      IP=IARY(IT,NN)
      GO TO 30
C CONTROL REACHES 340 IF THE SURF OF ORIGIN IS HORIZONTAL, SO A LARGER
C RANGE OF II VALUES CAN BE CONSIDERED AS SHOOTING ELMNTS.
 340  IF(JJ.LT.JVMX)GO TO 350
      JJ=JVMN-1
      IF(II.GE.IVMX)GO TO 500
      II=II+1
      IT=L+INCR
      IP=IARY(IT,NN)
C SELECT THE SHOOTING ELMNT J INDEX AND TEST FOR THE SHOOTING ELMNT
C BEING IN STATE 3.
 350  JJ=JJ+1
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
      IF(IF(IJ).EQ.0)GO TO 300
      GO TO 30
C CHECK FOR TARGET ELMNT BEING ON UNDERSIDE OF HATRACK
 25   IF(IARY(II,10).EQ.0)GO TO 35
      IP=IARY(II,10)
C SELECT TARGET ELMNT J INDEX AND SURFACE NUMBER, ICRIT.  TEST TO SEE
C IF FLAMES CAN REACH SURFACE ICRIT.
 30   JP=JJ
      ICRIT=IRAY(IP)
      IF(FHGT.LT.Z(ICRIT))GO TO 300
C UNPACK TARGET ELMNT STATE, PREVIOUS STATE, FRACTION CONSUMED, AND
C TIME-IN-STATE CLOCK.
      CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP)GO TO 300
      CALL CWORD(IWORD(IP,JP),ITX,ITY)
      KTEMP=IMATL(ICRIT)
      XTFC=ITFC(ICRIT)
      IF(XTFC.LE.0.) GO TO 300
C ITXX IS THE CURRENT TIME-TO-IGNITE FOR THE TARGET ELMNT MATERIAL.
      ITXX=ITF(ICRIT)
      GO TO 200
C TARGET ELMNT IS A CEILING OR OTHER OVERHEAD SURFACE ELMNT.
 35   IP=IARY(II,12)
      GO TO 30
C STMT 40 AND STMT 80 FORCE SELECTION OF ONLY SHOOTING ELMNTS ON THE
C UPPER SIDEWALLS OR HATRACKS.
 40   IF(I.LE.ICLL)GO TO 80
C SHOOTING ELMNT IS ON THE LEFT SIDE OF THE CABIN
      ICNTR=-1
      IF(VN(I,3).NE.1.0)GO TO 45
      IHRZ=1
      IX=IMAX(1)
C THE LOOP THRU 42 SELECTS THE TARGET ELMNT I INDEX, IP, AND CHECKS TO
C SEE THAT THE SHOOTING ELMNT IS FLAMING. ORIGIN SURFACE IS A HATRACK
C UPPER SURFACE.
      DO 42 LL=1,IX
      IF(IARY(LL,11).NE.II)GO TO 42
      L=LL
      INCR=1
      NN=12
```

```
      IP=IARY(L,NN)
      IF(IF(IJ).LT.1)GO TO 300
      GO TO 30
 42   CONTINUE
C CONTROL REACHES THIS ERROR MESSAGE ONLY IF NO PROPER TARGET ELMNT CAN
C BE FOUND ON THE CEILING.
      WRITE(6,43)
 43   FORMAT(/10X,20HNO CORRESP SURF,LEFT)
 999  STOP
 45   IF(VN(I,3).NE.0.)GO TO 500
C ORIGIN SURFACE IS VERTICAL. TEST FOR PRESENCE OF A HATRACK.
      IF(NPROJ.EQ.1)GO TO 65
C NO HATRACK. TARGET ELMNT IS ON CEILING
 50   L=1
 60   INCR=1
      NN=12
      IP=IARY(L,NN)
      GO TO 30
C TEST FOR ORIGIN SURFACE BEING ABOVE HATRACK (I LESS THAN IPJUL) OR
C BELOW HATRACK ( I GREATER THAN IPJLL).
 65   IF(I.LT.IPJUL)GO TO 50
 70   IF(I.GT.IPJLL)GO TO 75
C SET UP SEARCH LIMITS FOR SHOOTING ELMNT ON UPPER HATRACK SURFACE.
      IX=IMAX(1)
      DO 72 LL=1,IX
      IF(IARY(LL,11).NE.0)GO TO 72
      L=LL
      GO TO 60
 72   CONTINUE
C CONTROL REACHES THIS ERROR MESSAGE ONLY IF NO PROPER TARGET ELMNT CAN
C BE FOUND ON THE CEILING.
      WRITE(6,73)
 73   FORMAT(/10X,16HNO LEFT VERTICAL)
      GO TO 999
C SURFACE OF ORIGIN IS BELOW HATRACK, TARGET ELMNTS ON LWR HATRACK SURF.
 75   L=1
      INCR=1
      NN=10
      IP=IARY(L,NN)
      GO TO 30
C TEST FOR SURFACE OF ORIGIN BEING ON RIGHT SIDE OF CABIN.
 80   IF(I.GE.ICLR)GO TO 500
C SHOOTING ELMNT IS ON THE RIGHT SIDE OF THE CABIN.
      ICNTR=1
      IF(VN(I,3).NE.1.0)GO TO 85
C SURFACE OF ORIGIN IS HORIZONTAL
      IHRZ=1
      IX=IMAX(1)
      KJ=IX+1
C THE LOOP THRU STMT 82 SELECTS THE TARGET ELMNT I INDEX ON THE CEILING
      DO 82 LL=1,IX
      KJ=KJ-1
      IF(IARY(KJ,11).NE.II)GO TO 82
      L=KJ
      INCR=1
      NN=12
      IP=IARY(L,NN)
      IF(IF(IJ).EQ.0)GO TO 300
      GO TO 30
 82   CONTINUE
C CONTROL REACHES THIS ERROR MESSAGE IF NO CEILING TARGET ELMNT CAN
```

```
C BE FOUND.
      WRITE(6,83)
 83   FORMAT(/10X,19HNO CORRESP SURF,RGT)
      GO TO 999
C FOR VERTICAL SURFACES OF ORIGIN TEST FOR PRESENCE OF A HATRACK
 85   IF(VN(I,3).NE.0.)GO TO 500
      IF(NPROJ.EQ.1)GO TO 95
C NO HATRACK  - SELECT TARGET ELMNT ON CEILING.
      IX=IMAX(1)
 88   L=IX
 90   INCR=-1
      NN=12
      IP=IARY(L,NN)
      GO TO 30
C DETERMINE IF SURFACE OF ORIGIN IS ABOVE OR BELOW THE HATRACK
 95   IF(I.GT.IPJUR)GO TO 88
 97   IF(I.LT.IPJLR)GO TO 99
C SET UP SEARCH LIMITS FOR SHOOTING ELMNTS ON UPPER HATRACK SURFACE.
      IX=IMAX(1)
      KJ=IX+1
      DO 98 LL=1,IX
      KJ=KJ-1
      IF(IARY(KJ,11).NE.0)GO TO 98
      L=KJ
      GO TO 90
 98   CONTINUE
C CONTROL REACHES THIS ERROR MESSAGE ONLY IF NO PROPER TARGET ELMNT CAN
C BE FOUND ON THE CEILING.
      WRITE(6,981)
 981  FORMAT(/10X,24HNO CORRESP VERT SURF,RGT)
      GO TO 999
C SURFACE OF ORIGIN IS BELOW HATRACK. TARGET ELMNTS ON LWR HATRACK SURF.
 99   L=IMAX(1)
      INCR=-1
      NN=10
      IP=IARY(L,NN)
      GO TO 30
 500  RETURN
      END
```

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      SUBROUTINE PVOL(I)
C ----------------------------------------------------------------------
C OBJECTIVE
C (1) THIS SUBROUTINE COMPUTES THE INITIATION OF NEW SMOLDERING
C     REGIONS BY EXPOSURE OF ELMNTS TO THE RADIATION FROM THE FLAMES OF
C     A FIRE. THIS PROCESS IS MODELED BY (A) COMPUTING A "SMOLDERING
C     RANGE," PDH, WHICH IS THE DISTANCE AWAY FROM THE CYLINDRICAL
C     FLAME VOLUME AT WHICH THE RADIATION HAS FALLEN TO A VALUE OF QP;
C     (B) TESTING TO SEE IF ELMNTS WITHIN THE DISTANCE PDH FROM THE
C     FLAMES HAVE HAD A SUFFICIENTLY LONG EXPOSURE TO BEGIN SMOLDERING.
C     THE "SMOLDERING THRESHOLD" LEVEL QP AND RANGE PDH ARE COMPUTED IN
C     SUBR FIRE FROM DATA SUPPLIED FOR EACH MATERIAL TYPE AND THE
C     CURRENT LEVELS OF RADIATION FROM THE UPPER GAS ZONE.
C       ONLY FIRES ORIGINATING ON THE CABIN FLOOR OR ON THE UPPER HAT-
C     RACK SURFACES ARE CONSIDERED BY THIS SUBROUTINE. SUBROUTINE PVOLS
C     WORKS WITH FIRES ORIGINATING ON ANY SEAT GROUP.
C COMMENTS
C (1) TERMINOLOGY: ELMNTS ON THE FIRE BASE WHICH SERVE TO LOCATE THE
C     RADIATING FLAME VOLUME ARE CALLED "SHOOTING ELMNTS."  ELMNTS
C     BEING EXAMINED BY THIS SUBR AS CANDIDATES FOR THE TRANSITION TO
C     SMOLDERING ARE CALLED "TARGET ELMNTS."
C ----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT,DELTSP,ECOFLG,IDELT,IDENT(20),IDTPRV,IPEMS,
     1             IPSPR,IPAUX,IRATIO,ISAVE,ISCALE,ITFIN,ITIME,ITIM2,
     2             ITSPRD,NPASS,TFINAL,IDBUG1,EPSLN,MAXITR,MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7),ASM(7),ISTATE(120,15),ISTATS(9,16,22),
     1             IWORD(120,15),IWORDS(9,16,22),NFLM(7),NPYR(7),
     2             RGS(10,7),RSS(7),TOTGAS(10),TOTSEM,TRGF(10),
     3             TRGS(10),TRSF,TRSS,NCE(30),VITNR,TOTVIT,RADFIR(30),
     4             ACM(7),AF(30),AFI,AEXP,COMB(30),DGK,FLML(30),FSN1,
     5             FSN2,FSN3,GAMMA(30),IBURN,IF(600),IGMNI,IGMNJ,IGMXI,
     6             IGMXJ,IGNFIR,IGNIJ(2,100),IGSN,ISFIRE(30),IVMAX(30),
     7             IVMIN(30),IVMN,IVMX,IXFIRE,IZONE(30),JVMAX(30),
     8             JVMIN(30),JVMN,JVMX,K,NFE(30),NFIRES,NIJC,NIJSQ,
     9             NPE(30),NSFL(7),OMEGA(30),PDH,PIGN,RF(20,4),RFS(7,4),
     1             RFWS,RGF(10,7),RGFK(10),RHOZ(30),RSF(7),RSFK,TDQ,
     2             TBURNI,UZ(30),YZ(30),ZB(30),RHOEFG,CHIEFG(11),
     3             FLOWIN,FLWOUT,TEFG,IFRVNT,GENRAT(11),TDQMTL(7),
     4             TP(7),TPC(7)
      COMMON/GASES/CHIL(11,5),CHIU(11,5),CP,NGAS(11),NSPCS,PAMB,PF(5),
     1             RHOAM,RHOL(5),RHOU(5),TAM,TL(5),TU(5),VOLL(5),
     2             VOLU(5),ZD(5),XTHEN(120),WMOLEC(11),TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20),IMATS(7),IMTLP(4),IMAX(30),IMIN(30),
     1             IRAY(116),IRAYS(22),JMAX(30),JMIN(30),LSN,MAXELI,NS,
     2             CH,CL(4),CW,DWS,HSTS,IARX(40,15),IARY(40,12),ICLL,
     3             ICLR,IEND,IFIRL,IFIRR,ILSTL,ILSTR,IONE(9),
     4             ISSWLI(9,10),ISSWLJ(9,10),ISSWRI(9,10),ISSWRJ(9,10),
     5             ISWSL(15,8),ISWSR(15,8),ISTART,NPROJ,IPJUL,IPJLL,
     6             IPJUR,IPJLR,JEND,JONE(9),JSTART,NJS,NSG,NV,SGWD(9),
     7             SL,SWD(20),VN(20,3),VENTH(24),VENTW(24),VENTT(24),
     8             XMN(30),XMX(30),XCOR(9),YCOR(9),Z(30),SSGWD,TVSG,
     9             HT1,HT2,HT3,HT4(10),NSSTS,SLSW,SX(30),SZ(30),
     1             CNCTNS(24),NCOMPS,IFRCMP,FLOW(24),INTO(24),VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6),TABY(18,7,6),NTXG,FOXI,RADTAB(7),RADI,
     1             FOX(7),NMATLS,DQI,DQM(7),QAMI,QTAB(7),ITF(20),IRAMPT,
     2             ITFC(20),ITFCS(7),ITFS(7),ITP(20),ITPC(20),ITPCS(7),
     3             ITPE(20),ITPES(7),ITPS(7),QCI,QP(7),QTAB(7),RHOI,
     4             RHOM(7),RSI,RTAB(7),RTGI(10),UTAB(7),CNDCTY(7),XMUI,
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5              XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
6              WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, QC(2)
      DIMENSION ISD(4)
C SKIP ALL SURFACES OF ORIGIN EXCEPT THE FLOOR AND THE UPPER HATRACK.
      IF(I.EQ.1)GO TO 2
      IF(I.EQ.IPJUL .OR. I.EQ.IPJUR)GO TO 2
      GO TO 500
C FHGT = FIRE BASE DISPLACEMENT  +  FLAME LENGTH FOR THE CURRENT FIRE.
C ICON IS A CONVERSION FACTOR USED WITH THE ARRAY IF.
 2    FHGT=ZB(K)+FLML(K)
      ICON=IEND-ISTART+1
C STMTS 10 AND 20 ARE THE BEGINNING OF LOOPS OVER THE I AND J INDICES OF
C THE SHOOTING ELMNTS ON THE BASE OF THE CURRENT FIRE.
      II=IVMN-1
 10   II=II+1
      JJ=JVMN-1
      KK=IRAY(II)
 20   JJ=JJ+1
C USE THE ARRAY IF TO DETERMINE WHETHER ELMNT II, JJ IS FLAMING AND, IF
C SO, IF IT IS ON THE PERIMETER OF A FIRE BASE. SET THE FLAG IRET
C ACCORDINGLY.
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
      IF(IF(IJ)-1) 300,26,27
C SHOOTING ELMNT AFLAME, NOT ON PERIMETER => IRET = 2.
 26   IRET=2
      GO TO 28
C SHOOTING ELMNT AFLAME, ON PERIMETER => IRET = 1.
 27   IRET=1
C SELECT CANDIDATE TARGET ELMNT INDICES IP AND JP.
 28   IP=II
      JP=JJ
      GO TO 180
C USE SUBR ISIDE TO DETERMINE WHICH SIDE(S) OF THE SHOOTING ELMNT II, JJ
C HAS A NON-FLAMING NEIGHBOR.
 30   CALL ISIDE(IF(IJ),ISD)
C CHECK TO SEE WHETHER THE SMOLDERING RANGE COVERS A LEAST ONE ELMNT
C DIMENSION. IF NOT SKIP TO 300 TO CONSIDER OTHER SHOOTING ELMNTS.
      NSGH=PDH/SQD
      IF(NSGH.LT.1) GO TO 300
C SET UP A LOOP ON L TO CONSIDER THE FOUR POSSIBLE DIRECTIONS AWAY FROM
C THE SHOOTING ELMNT.
      NSG=0
 40   L=0
 50   L=L+1
      IF(ISD(L).EQ.1) GO TO 70
 60   IF(L.EQ.4) GO TO 300
      NSG=0
      GO TO 50
C NSG COUNTS THE NUMBER OF ELMNTS TO STEP OUT FROM THE EDGE OF THE BASE
 70   NSG=NSG+1
C BASED ON THE DIRECTION INDICATED BY L SELECT TARGET ELMNT'S I AND J
C INDICES.  CHECK IN EACH CASE AGAINST JUMPING OFF A SURFACE EDGE.
C IRET = 3 INDICATES A NEED TO CONTINUE STEPPING OUT FROM THE FIRE
C PERIMETER TO CHECK ADDITIONAL TARGET ELMNTS.
      GO TO(80,90,100,110),L
C
 80   IP=II
      JP=JJ-NSG
      IF(JP LT 1) GO TO 60
```

```
 85   IRET=3
      GO TO 122
 90   IP=II
      JP=JJ+NSG
      IF(JP.GT.JEND) GO TO 60
      GO TO 85
 100  IP=II-NSG
      JP=JJ
      IF(IP.LT.IMIN(KK)) GO TO 60
      GO TO 85
 110  IP=II+NSG
      JP=JJ
      IF(IP.GT.IMAX(KK))GO TO 60
      GO TO 85
C UNPACK THE DATA ON THE TARGET ELMNT AND TEST FOR EQUALITY OF THE
C PRESENT STATE AND THE PREVIOUS STATE.  THEY MUST BE EQUAL FOR A
C CHANGE OF STATE TO BE ALLOWED.
 122  CALL CVOUT(IP,JP,KK,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP) GO TO 160
 123  CALL CWORD(IWORD(IP,JP),ITX,ITY)
C SELECT THE STATE TRANSITION: TARGET ELMNTS IN STATES 3, 4 OR 7 ARE
C IGNORED; STATE 1 -> STATE 5; STATE 5 -> STATE 2 IF THEIR TIME IN STATE
C 5 HAS EXCEEDED THE CURRENTLY APPLICABLE TIME-TO-START-SMOLDERING.
C ELMNTS ALREADY IN STATE 2 REMAIN THERE.
      GO TO(124,130,160,160,130,125,160),IST
 124  ITX=0
 125  IST=5
      GO TO 140
 130  IF(IST.EQ.2) GOTO 135
      IF(ITX.LT.ITP(KK)) GO TO 135
      IST=2
      XTPC=ITPC(KK)
      IF(XTPC.LE.0.) GO TO 160
      ITEMP=(DELTSP/XTPC)*THOU
      ITFCP=ITFCP+ITEMP
      ITX=ITX-ITP(KK)
      NPE(KK)=NPE(KK)+1
 135  ITY=-1
 140  ISG=1
C REPACK STATE DATA FOR THIS TARGET ELMNT.
      IF(ITY.LT.0) ISG=-1
      IWORD(IP,JP)=ITY*10000+ISG*ITX
      ISTATE(IP,JP)=ITFCP*100+ISTP*10+IST
 160  CONTINUE
C THE REMAINING PART OF THIS SUBROUTINE CONSIDERS SMOLDERING INDUCED ON
C SURFACES ABOVE THE FLAME VOLUME.  SEE SECTION 4.2.3 OF [1].
C SKIP TO 189 IF THE FIRE IS ON THE FLOOR.
 180  IF(I.EQ.1)GO TO 189
C THE LOOP THRU 182 SEARCHES FOR TARGET ELMNTS ON THE CEILING FOR FIRES
C ORIGINATING ON THE UPPER HATRACK SURFACES (IF APPLICABLE).
      IX=IMAX(1)
      DO 182 LL=1,IX
      IF(IP.NE.IARY(LL,11))GO TO 182
      M=LL
      IPP=IARY(M,12)
      GO TO 192
 182  CONTINUE
C CONTROL REACHES THIS ERROR MESSAGE ONLY IF NO TARGET ELMNTS ARE FOUND
C ON THE CEILING.
      WRITE(6,183)
 183  FORMAT(/5X,26HPVOL--HR SURFACE NOT FOUND)
```

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      STOP
C FIRE IS ON THE CABIN FLOOR - TEST FOR SEATS ABOVE THE SHOOTING ELMNT.
 189  IS=IARX(IP,JP)
      IF(IS.EQ.0)GO TO 190
C A SEAT IS ABOVE THE SHOOTING ELMNT, COMPUTE THE RADIATION LEVEL TO
C WHICH THE TARGET ELMNT IS EXPOSED.
      ICRIT=LSN+IS
      ZZ=Z(ICRIT)-FHGT
      XTEM=(ZZ*ZZ/(YZ(K)*YZ(K)))*4.0
      QCS=6.52*(1.-((XTEM-3.)/SQRT((9.+XTEM)*(1.+XTEM))))
      IMT=IMATS(1)
C IF THE EXPOSURE LEVEL IS LESS THAN THE THRESHOLD LEVEL, QP, END
C CONSIDERATION OF THIS ELMNT.
      IF(QCS.LE.QP(IMT))GO TO 250
C SELECT THE INDICES OF THE TARGET SEAT ELMNT, UNPACK ITS STATE DATA,
C CHECK FOR EQUALITY OF PAST AND PRESENT STATE.
      IPP=IP-IONE(IS)
      JPP=JP-JONE(IS)
      CALL CVOUT(IPP,JPP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP)GO TO 250
      CALL CWORD(IWORDS(IS,IPP,JPP),ITX,ITY)
C CHECK THE FRACTION CONSUMED FOR THE TARGET ELMNT, AND SKIP TO 210 FOR
C APPROPRIATE STATE TRANSITION.
      KTEMP=IMATS(1)
      XTPC=ITPCS(1)
      IF(XTPC.LE.0.) GO TO 250
      ITXX=ITPS(1)
      GO TO 210
C FIRE IS ON THE FLOOR BUT NO SEATS ARE ABOVE THE SHOOTING ELMNT
C DETERMINE IF THE TARGET ELMNT IS ON A HATRACK LOWER SURFACE OR ON THE
C CEILING
 190  IPP=IARY(II,10)
      IF(IPP.EQ.0)IPP=IARY(IP,12)
 192  JPP=JP
      ICRIT=IRAY(IPP)
      ZZ=Z(ICRIT)-FHGT
      XTEM=(ZZ*ZZ/(YZ(K)*YZ(K)))*4.0
C USE EQ 4-6 OF [1] TO COMPUTE THE RADIATION FLUX AT THE TARGET.
      QCS=6.52*(1.-((XTEM-3.)/SQRT((9.+XTEM)*(1.+XTEM))))+
     1       .00138*(2.25*TL(IFRCMP)-TAM)
      KTEMP=IMATL(ICRIT)
C IF THE EXPOSURE LEVEL IS LESS THAN THE THRESHOLD LEVEL END
C CONSIDERATION OF THIS ELMNT.
      IF(QCS.LE.QP(KTEMP))GO TO 250
C UNPACK THE TARGET ELMNT STATE DATA, CHECK THE PRESENT AND PAST STATES,
C AND THE FRACTION CONSUMED.
      CALL CVOUT(IPP,JPP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP)GO TO 250
      CALL CWORD(IWORD(IPP,JPP),ITX,ITY)
      XTPC=ITPC(ICRIT)
      IF(XTPC.LE.0.) GO TO 250
      ITXX=ITP(ICRIT)
C SELECT STATE TRANSITION: ELMNTS IN STATES 3, 4 AND 7 ARE IGNORED;
C STATE 1 -> STATE 5; STATE 5 -> STATE 2 IF THEIR TIME IN STATE 5 HAS
C EXCEEDED THE CURRENTLY APPLICABLE TIME-TO-START-SMOLDERING. ELMNTS
C CURRENTLY IN STATE 2 REMAIN THERE.
 210  GO TO(211,215,250,250,215,212,250),IST
 211  ITX=0
 212  IST=5
      GO TO 230
 215  IF(IST.EQ.2) GO TO 220
```

```
      IF(ITX.LT.ITXX)GO TO 220
      IST=2
      JTEMP=(DELTSP/XTPC)*THOU
      ITFCP=ITFCP+JTEMP
      ITX=ITX-ITXX
      NPE(ICRIT)=NPE(ICRIT)+1
C REPACK THE NEW STATE DATA FOR THE TARGET ELMNT IN THE LINING SURFACES
C OR SEAT SURFACES ARRAYS AS APPROPRIATE.
 220  ITY=-1
 230  ISG=1
      IF(ITY.LT.0) ISG=-1
      IT1=ITY*10000+ISG*ITX
      IT2=ITFCP*100+ISTP*10+IST
      IF(ICRIT.GT.LSN)GO TO 235
      IWORD(IPP,JPP)=IT1
      ISTATE(IPP,JPP)=IT2
      GO TO 250
 235  IWORDS(IS,IPP,JPP)=IT1
      ISTATS(IS,IPP,JPP)=IT2
 250  IF(IRET-2)30,300,260
C THIS TEST CHECKS TO FIND IF ALL ELMNTS WITHIN THE SMOLDERING RANGE
C HAVE BEEN EXAMINED.
 260  IF(NSQ.LT.NSQH)GO TO 70
      GO TO 60
C END OF THE LOOPS OVER THE SHOOTING ELMNTS.
 300  IF(JJ.LT.JVMX)GO TO 20
      IF(II.LT.IVMX)GO TO 10
 500  RETURN
      END
```

```
      SUBROUTINE CONDS(I)
C ------------------------------------------------------------------
C OBJECTIVE
C (1) SUBROUTINE CONDS COMPUTES THE SPREAD OF FIRE OVER THE SURFACES OF
C     THE SEAT GROUP SPECIFIED BY THE VALUE OF I IN THE SUBROUTINE CALL.
C     THE SUBROUTINE ALSO COMPUTES THE SPREAD OF FIRE TO SIDEWALLS NEAR
C     THE EDGE OF A SEAT GROUP AND TO SEAT GROUPS FORWARD AND AFT OF
C     THE SPECIFIED SEAT GROUP.
C ------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DQK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDQ,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDQMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTU(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DQI, DQM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SQD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, QC(2)
      DIMENSION ISD(4)
C COMPUTE THE SEAT GROUP NUMBER FROM THE VALUE OF I.  COMPUTE THE
C CONSTANT ICON USED WITH THE ARRAY IF
      IS=I-LSN
      ICON=IEND-ISTART+1
C STMTS 10 AND 20 START LOOPS OVER SEAT GROUP ELMNTS II, JJ WHICH ARE
C THE ORIGIN ELEMENTS FOR THE FLAME SPREAD.
      II=IVMN-1
      JJ=JVMN-1
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 10    JJ=JJ+1
       KK=IRAYS(JJ)
 20    II=II+1
       IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
C IF THE ARRAY IF FOR THIS ELMNT CONTAINS A VALUE OF ZERO, THE ELMNT IS
C NOT FLAMING
       IF(IF(IJ).EQ.0)GO TO 190
C USE SUBR ISIDE TO DETERMINE THE OPEN SIDES (IF ANY) OF THE ORIGINATING
C ELEMENT, AND SUBR CWORD TO UNPACK THE ELMNT STATE DATA.
 25    CALL ISIDE(IF(IJ),ISD)
       CALL CWORD(IWORDS(IS,II,JJ),ITX,ITY)
       TXO=ITX
C IF IF HAS THE VALUE 1, THE ELMNT II, JJ IS AN INTERIOR ELMNT (HAS NO
C SIDES ON THE FIRE PERIMETER). SO SKIP TO 120 FOR SIDEWALL OR SEAT
C SPREAD TESTS.
       IF(IF(IJ).EQ.1)GO TO 120
       KX=KK
       L=1
C STMT 30 IS THE START OF A LOOP TO EXAMINE EACH OF THE 4 POSSIBLE
C SPREADING DIRECTIONS (GIVEN BY THE VALUE OF L). THE VALUE OF ISD(L)
C OF ZERO INDICATES WHETHER A GIVEN SIDE IN THE DIRECTION L IS OPEN.
C RFS IS THE CURRENT SPREAD RATE FOR SEAT MATERIALS.
 30    IF(RFS(KK,L).LE.0.0) GO TO 110
       IF(ISD(L).LE.0) GO TO 110
C COMPUTE THE TIME TO SPREAD AND COMPARE IT TO THE CURRENT TIME-IN-STATE
C FOR THE ORIGIN ELMNT.
       TIMSP=SQD/RFS(KK,L)
       IF(TXO.LT.TIMSP) GO TO 110
C IF SPREAD SHOULD OCCUR SELECT THE APPROPRIATE DIRECTION AND COMPUTE
C THE INDICES, IDXI AND IDXJ, OF THE ELMNT WHICH IS A CANDIDATE FOR
C IGNITION.
       GO TO(40,50,60,70),L
 40    IF((JJ-1).LT.1) GO TO 45
       IDXJ=JJ-1
       GO TO 47
 45    IDXJ=JMAX(I)
 47    IDXI=II
 48    KV=IRAYS(IDXJ)
       GO TO 82
 50    IF((JJ+1).GT.JMAX(I)) GO TO 55
       IDXJ=JJ+1
       GO TO 47
 55    IDXJ=1
       GO TO 47
 60    IF(II.EQ.1)GO TO 110
       IDXI=II-1
   67  IDXJ=JJ
       GO TO 48
 70    IF(II.EQ.IMAX(I))GO TO 110
       IDXI=II+1
       GO TO 67
C UNPACK THE STATE DATA FOR THE CANDIDATE ELMNT.
 82    CALL CVOUT(IDXI,IDXJ,I,IST,ISTP,ITFCP)
       CALL CWORD(IWORDS(IS,IDXI,IDXJ),ITX,ITY)
C ELMNTS IN STATES 1,2,5, AND 6 ARE IGNITED. THOSE IN STATES 3,4 AND 7
C ARE SKIPPED.
       GO TO (83,83,110,110,83,83,110),IST
C UPDATE THE RATES OF HEAT, SMOKE, AND GAS RELEASE AND OXYGEN
C CONSUMPTION TO REFLECT THE NEW IGNITION. COMPUTE THE NEW VALUE OF
C FRACTION CONSUMED, ITFCP, AND SET THE TIME-IN-STATE CLOCK, ITX, TO
C ZERO.
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 83   IF(IST.EQ.2) NPE(I)=NPE(I)-1
      KTEMP=IMATS(KV)
      DGK=DGK+GTR*DGM(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + GTR * DGM(KTEMP)
      RSFK=RSFK+GTR*RSF(KTEMP)
      VITNR=VITNR+GTR*DGM(KTEMP)/FOX(KTEMP)
      DO 85 IG=1,NTXG
 85   RGFK(IG)=RGFK(IG)+GTR*RGF(IG,KTEMP)
      XTFC=ITFCS(KV)
      IF(XTFC.LE.0.) GO TO 110
      KTEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+KTEMP
 90   IST=3
C REPACK THE ELMNT STATE DATA
      ITX=0
      NFE(I)=NFE(I)+1
      ISG=1
      IF(ITY.LT.0) ISG=-1
      IWORDS(IS,IDXI,IDXJ)=ITY*10000+ISG*ITX
      ISTATS(IS,IDXI,IDXJ)=ITFCP*100+ISTP*10+IST
C IF ALL 4 DIRECTIONS HAVE BEEN CHECKED JUMP TO 120, IF NOT RETURN TO 30
 110  IF(L.GE.4) GO TO 120
      L=L+1
      GO TO 30
C THE NEXT 35 STMTS CONCERN THE SPREAD OF FIRE TO THE SIDEWALLS FROM THE
C SEATS. FIRST THE SEAT ELMNT MUST BE IN THE CORRECT POSITION (CUSHION
C TOP OR REAR OF BACKREST) AND MUST HAVE BEEN BURNING FOR THE REQUIRED
C LENGTH OF TIME, TIMWS. FINALLY THE SEAT MUST BE WITHIN ONE ELMNT'S
C DISTANCE FROM THE SIDEWALL.
 120  CONTINUE
 124  IF(JJ.GT.5 .AND. JJ.LT.13) GO TO 190
      IF(JJ.GT.18 .AND. JJ.LT.22) GO TO 190
      IF(JJ.EQ.5)GO TO 145
      IF(JJ.EQ.22)GO TO 150
      IF(RFWS.LE.0.)GO TO 190
      TIMWS=DWS/RFWS
      IF(TXO.LT.TIMWS)GO TO 190
      IX=2.0*SGWD(IS)+TOL
      IF(II.NE.1 .OR. IONE(IS).GT.2)GO TO 135
C SEAT GROUP IS NEXT TO THE LEFT SIDEWALL.
      IF(JJ.GT.12 .AND. JJ.LT.19)GO TO 130
C USE THE ARRAYS ISSWLI AND ISSWLJ TO COMPUTE THE SPREAD FROM SEAT
C CUSHIONS TO THE SIDEWALL - LEFT SIDE.
      IP=ISSWLI(IS,JJ)
      JP=ISSWLJ(IS,JJ)
 125  ICRIT=IRAY(IP)
      CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP) GO TO 190
      CALL CWORD(IWORD(IP,JP),ITX,ITY)
      KTEMP=IMATL(ICRIT)
      XTFC=ITFC(ICRIT)
      IF(XTFC.LE.0.) GO TO 190
      GO TO 154
C USE THE ARRAYS ISSWLI AND ISSWLJ TO COMPUTE THE SPREAD FROM SEAT
C BACKRESTS TO THE SIDEWALL - LEFT SIDE.
 130  JX=JJ-8
      IP=ISSWLI(IS,JX)
      JP=ISSWLJ(IS,JX)
      GO TO 125
C SEAT GROUP IS NEXT TO THE RIGHT SIDEWALL.
 135  IY=IX+IONE(IS)+1
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      IF(II.NE.IX .OR. IY.LT.IMAX(1))GO TO 190
      IF(JJ.GT.12 .AND. JJ.LT.19) GO TO 140
C USE THE ARRAYS ISSWRI AND ISSWRJ TO COMPUTE THE SPREAD FROM SEAT
C CUSHIONS TO THE SIDEWALL - RIGHT SIDE.
      IP=ISSWRI(IS,JJ)
      JP=ISSWRJ(IS,JJ)
      GO TO 125
C USE THE ARRAYS ISSWRI AND ISSWRJ TO COMPUTE THE SPREAD FROM SEAT
C BACKRESTS TO THE SIDEWALL - RIGHT SIDE.
 140  JX=JJ-8
      IP=ISSWRI(IS,JX)
      JP=ISSWRJ(IS,JX)
      GO TO 125
C THE NEXT 30 STMTS CONSIDER FIRE SPREAD BY FLAMES JUMPING FROM THE
C FRONT OF ONE SEAT GROUP TO THE BACK OF ANOTHER OR VICE VERSA.
C THE POSSIBILITY OF A JUMP OCCURS ONLY WHEN THE FORE-AFT SEPARATION
C BETWEEN TWO SEAT GROUPS IS TWO OR LESS ELMNT WIDTHS.
C FIRST CHECK FOR SPREAD FROM THE BACK OF THE CURRENT SEAT GROUP TO THE
C FRONT OF THE ONE BEHIND IT (IF ANY).  IP AND JP ARE THE "TARGET ELMNT"
C INDICES ON THE SEAT TO BE IGNITED.
 145  I1=IS+1
      IF(I1.GE.9)GO TO 190
      I2=9
      IK=IS
      L=IONE(IS)+II
      DO 146 IJ=I1,I2
      IK=IK+1
      IF(IARY(L,IK).NE.0)GO TO 147
 146  CONTINUE
      GO TO 190
 147  IF((JONE(IK)-JONE(IS)+3).GT.2)GO TO 190
      IP=IARY(L,IK)
      JP=22
      KJ=7
 148  ICRIT=IK+LSN
      CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP)GO TO 190
      CALL CWORD(IWORDS(IS,IP,JP),ITX,ITY)
      KTEMP=IMATS(KJ)
      XTFC=ITFCS(KJ)
      IF(XTFC.LE.0.) GO TO 190
      GO TO 154
C CHECK FOR SPREAD FROM THE CURRENT SEAT GROUP TO THE ONE AHEAD OF IT.
C IP AND JP ARE THE TARGET ELMNT INDICES OF THE SEAT AHEAD.
 150  I2=IS-1
      IF(I2.LE.1)GO TO 190
      I1=1
      IK=IS
      L=IONE(IS)+II
      DO 151 IJ=I1,I2
      IK=IK-1
      IF(IARY(L,IK).NE.0)GO TO 152
 151  CONTINUE
      GO TO 190
 152  IF((JONE(IS)-JONE(IK)+3).GT.2)GO TO 190
      IP=IARY(L,IK)
      JP=5
      KJ=2
      GO TO 148
C ELMNTS IN STATES 1,2,5, AND 6 WILL BE IGNITED; OTHERS ARE SKIPPED.
C ADJUST THE PRODUCT GENERATION RATES AND OXYGEN CONSUMPTION RATES
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C FOR THE EFFECT OF THE IGNITED ELMNTS
 154  GO TO(155,155,190,190,155,155,190),IST
 155  IF(IST.EQ.2) NPE(ICRIT)=NPE(ICRIT)-1
      DGK=DGK+QTR*DGM(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + QTR * DGM(KTEMP)
      RSFK=RSFK+QTR*RSF(KTEMP)
      VITNR=VITNR+QTR*DGM(KTEMP)/FOX(KTEMP)
      DO 160 IG=1,NTXG
 160  RGFK(IG)=RGFK(IG)+QTR*RGF(IG,KTEMP)
      ITEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+ITEMP
 170  IST=3
      ITX=0
      NFE(ICRIT)=NFE(ICRIT)+1
C REPACK THE ELMNT STATE DATA FOR LINING SURFACES OR SEATS AS REQUIRED.
      ISG=1
      IF(ITY.LT.0) ISG=-1
      IT1=ITY*10000+ISG*ITX
      IT2=ITFCP*100+ISTP*10+IST
      IF(ICRIT.GT.LSN)GO TO 180
      IWORD(IP,JP)=IT1
      ISTATE(IP,JP)=IT2
      GO TO 190
 180  IWORDS(IS,IP,JP)=IT1
      ISTATS(IS,IP,JP)=IT2
C END OF LOOPS OVER ORIGINATING ELMNTS.
 190  IF(II.LT.IVMX) GO TO 20
      II=IVMN-1
      IF(JJ.LT.JVMX) GO TO 10
      RETURN
      END
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      SUBROUTINE FCONS(I)
C ----------------------------------------------------------------------
C OBJECTIVE
C (1) SUBROUTINE FCONS COMPUTES THE FIRE SPREAD DUE TO FLAMES FROM A
C     FIRE ON A SEAT GROUP CONTACTING CEILING AND/OR HAT RACK ELMNTS
C COMMENTS
C (1) TERMINOLOGY OF "SHOOTING" AND "TARGET" ELMNTS APPLIES.  SEE SUBR
C     FCON.
C ----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1              IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2              ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3              JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1              IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2              RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3              TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4              ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5              FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6              IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7              IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8              JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9              NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1              RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2              TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3              FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4              TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1              RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2              VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3              JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1              IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2              CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3              ICLR, IEND, IFIRL, ILSTL, ILSTR, IONE(9),
     4              ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5              ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6              IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7              SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8              XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9              HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1              CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2              FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1              FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2              ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3              ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4              RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5              XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6              WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, QTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, QC(2)
C FHGT = BASE DISPLACEMENT FOR FIRE K  +  FLAME LENGTH OF THE FIRE
      FHGT=ZB(K)+FLML(K)
C IF FHGT IS LESS THAN FHMIN, FLAMES DO NOT TOUCH OVERHEAD SURFACES
      IF(FHGT.LT.FHMIN)GO TO 500
C FLAG IXFIRE, SET IN SUBR FIRE, SIGNALS THE SEAT FIRE LOCATION:
C  IXFIRE = 1 => CUSHION BOTTOM.  =2 => CUSHION TOP.  =3 => BACKREST.
      IF(IXFIRE-2)500,5,7
C IF THE FIRE IS ON THE CUSHION TOP TEST NSFL(7) TO FIND IF IT IS ALL
C ON THE FRONT SURFACE (7) ELEMENT.  IF SO, RETURN.
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 5     IT=FSN2+TOL
       IF(IT.EQ.NSFL(7))GO TO 500
       GO TO 10
C IF THE FIRE IS ON THE BACKREST TEST NSFL(4) TO FIND IF IT IS ALL ON
C SEAT SURF 4 AND SO IS TOO SMALL TO CONTACT OVERHEAD SURFACES.
 7     IT=FSN3+TOL
       IF(IT.EQ.NSFL(4))GO TO 500
C COMPUTE SEAT GROUP NUMBER FROM THE VALUE OF I
 10    IS=I-LSN
C STMTS 15 AND 20 START LOOPS OVER THE SHOOTING ELMNTS GIVEN BY II, JJ.
       II=IVMN-1
       JJ=JVMN-1
       ICON=IEND-ISTART+1
 15    JJ=JJ+1
 20    II=II+1
       IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
C USE THE ARRAY IF TO FIND IF THE SHOOTING ELMNT II, JJ IS FLAMING.
       IF(IF(IJ).LT.1)GO TO 100
       L=IONE(IS)+II
C USE THE ARRAY IARY TO FIND (1) IF THE OVERHEAD SURFACE IS A HATRACK
C OR A CEILING/PSU/STOW-BIN SURF AND (2) ITS DISPLACEMENT FROM THE FLOOR
       IDX=12
       IF(IARY(L,10).NE.0)IDX=10
       IP=IARY(L,IDX)
       ICRIT=IRAY(IP)
C CHECK TO SEE IF THE FLAMES REACH THE OVERHEAD SURFACE.
       IF(FHGT.LT.Z(ICRIT))GO TO 100
       IF(JJ.GT.18)GO TO 35
C SHOOTING ELMNT II, JJ IS ON THE BACKREST, SELECT TARGET ELMNT J INDEX
 30    JP=JONE(IS)+4
       GO TO 40
C SHOOTING ELMNT II, JJ IS ON THE CUSHION TOP, SELECT TARGET J INDEX
C SKIPPING ROW 22, THE CUSHION FRONT.
 35    IF(JJ.EQ.22)GO TO 100
       JP=JONE(IS)+22-JJ
C UNPACK THE TARGET ELMNT STATE DATA.
 40    CALL CVOUT(IP,JP,ICRIT,IST,ISTP,ITFCP)
       CALL CWORD(IWORD(IP,JP),ITX,ITY)
C SELECT THE STATE TRANSITION APPROPRIATE TO THE TARGET ELMNTS CURRENT
C STATE: 1 -> 6, 2 -> 3, SKIP 3 AND 4, 5 -> 6, 6 -> 3, SKIP 7. THE
C TRANSITION 6 -> 3 IS MADE ONLY IF THE TARGET ELMNT HAS BEEN IN STATE
C 6 LONGER THAN THE CURRENTLY APPLICABLE IGNITION TIME FOR THIS MATERIAL
 55    GO TO(58,70,95,95,60,70,95),IST
 58    ITX=0
 60    IST=6
       GO TO 90
 70    IF(IST.EQ.2) GO TO 75
       IF(ITX.LT.ITF(ICRIT))GO TO 95
       ITX=ITX-ITF(ICRIT)
       GO TO 80
 75    CONTINUE
       ITX=0
       NPE(ICRIT)=NPE(ICRIT)-1
 80    IST=3
C UPDATE THE PRODUCT GENERATION RATES AND OXYGEN CONSUMPTION RATES TO
C REFLECT THE NEW IGNITION OF THE TARGET ELMNT.
       KTEMP=IMATL(ICRIT)
       DGK=DGK+GTR*DGM(KTEMP)
       TDGMTL(KTEMP) = TDGMTL(KTEMP) + GTR * DGM(KTEMP)
       RSFK=RSFK+GTR*RSF(KTEMP)
       VITNR=VITNR+GTR*DGM(KTEMP)/FOX(KTEMP)
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      DO 82 IG=1,NTXG
 82   RGFK(IG)=RGFK(IG)+QTR*RGF(IG,KTEMP)
C UPDATE THE FRACTION CONSUMED FOR THE TARGET ELMNT.
      XTFC=ITFC(ICRIT)
      IF(XTFC.LE.0.) GO TO 100
      KTEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+KTEMP
      NFE(ICRIT)=NFE(ICRIT)+1
C REPACK THE STATE ARRAYS FOR THE TARGET ELMNT.
 90   ISG=1
      IF(ITY.LT.0) ISG=-1
      IWORD(IP,JP)=ITY*10000+ISG*ITX
      ISTATE(IP,JP)=ITFCP*100+ISTP*10+IST
C FOR SHOOTING ELMNTS ON THE BACKREST SKIP OUT OF THE JJ LOOP TO
C CONSIDER A NEW II VALUE SINCE THE TARGET ELMNTS WILL BE THE SAME FOR
C ALL JJ VALUES AT FIXED II.
      IF(IXFIRE.EQ.3)GO TO 110
 95   CONTINUE
C END OF THE LOOPS OVER THE SHOOTING ELMNTS.
 100  IF(II.LT.IVMX)GO TO 20
 110  II=IVMN-1
      IF(JJ.LT.JVMX)GO TO 15
 500  RETURN
      END
```

```
      SUBROUTINE PVOLS(I)
C ---------------------------------------------------------------------
C OBJECTIVE
C (1) SUBROUTINE PVOLS COMPUTES THE INITIATION OF NEW REGIONS OF
C     SMOLDERING ON THE SEATS, CEILING AND/OR HAT RACKS DUE TO THE
C     RADIATION FROM FLAMES OF FIRE ON THE SEAT GROUP GIVEN BY THE VALUE
C     OF I.
C COMMENTS
C (1) THE TERMINOLOGY OF "SHOOTING" AND "TARGET" ELMNTS APPLIES.  SEE
C     SUBR PVOL.
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      DIMENSION ISD(4)
C ICON IS A CONSTANT USED WITH ARRAY IF.
C FHGT = FIRE BASE DISPLACEMENT  +  FLAME LENGTH
      ICON=IEND-ISTART+1
      FHGT=ZB(K)+FLML(K)
      JJ=0
C IF THE FIRE IS ON THE CUSHION BOTTOM SKIP IT AND RETURN (IXFIRE = 1)
```

```
      IF(IXFIRE-2)500,5,7
C IF THE FIRE IS TOTALLY ON THE CUSHION FRONT SURFACE (7), SKIP IT AND
C RETURN.
 5    IT=FSN2+TOL
      IF(IT.LE.NSFL(7))GO TO 500
      GO TO 10
C IF THE FIRE IS ONLY ON THE TOP OF THE BACKREST (SURFACE 4) SKIP IT AND
C RETURN.
 7    IT=FSN3+TOL
      IF(IT.LE.NSFL(4))GO TO 500
      JJ=11
C COMPUTE THE SEAT GROUP NUMBER FROM THE VALUE OF I.
 10   IS=I-LSN
C STMTS 15 AND 20 START LOOPS OVER THE SHOOTING ELMNTS II, JJ.
      II=IVMN-1
      IF(JJ.EQ.11)GO TO 15
      JJ=JVMN-1
 15   JJ=JJ+1
 20   II=II+1
      IJ=(II-ISTART+1)+ICON*(JJ-JSTART)
C IXFIRE = 3 => FIRE ON BACKREST, IF NOT SET IRET =2 => LATERAL
C INFLUENCE COMPUTATIONS NOT REQUIRED.
      IF(IXFIRE.NE.3)GO TO 22
      IRET=2
      GO TO 28
 22   IF(IF(IJ)-1)500,26,27
C SHOOTING ELMNT IS NOT ON THE BASE PERIMETER, SET IRET = 2
 26   IRET=2
      GO TO 28
C SHOOTING ELMNT IS ON THE BASE PERIMETER, IRET = 1
 27   IRET=1
C SAVE THE SHOOTING ELMNT INDICES AS IP, JP AND SET IRET = 1 TO SIGNAL
C LATERAL INFLUENCE COMPUTATIONS REQUIRED.
 28   IP=II
      JP=JJ
      KK=IRAYS(JP)
      GO TO 180
C CONTROL REACHES STMT 30 IF SMOLDERING OF ELEMENTS NEXT TO AND ON THE
C SAME SURFACE AS THE FIRE BASE IS TO BE CONSIDERED.  USE ISIDE TO
C DETERMINE WHICH SIDES OF THE SHOOTING ELEMENT ARE ADJACENT TO
C NON-BURNING, AND THUS CANDIDATE TARGET ELEMENTS.
 30   CALL ISIDE(IF(IJ),ISD)
C COMPUTE THE SMOLDERING RANGE IN TERMS OF THE NUMBER OF ELMNT
C DIMENSIONS
      NSGH=PDH/SGD
      IF(NSGH.LT.1)GO TO 300
      NSG=0
C PREPARE TO FORM A LOOP OVER THE 4 DIRECTIONS OUT FROM THE SHOOTING
C ELMNT.  L INDICATES THE CURRENT CHOICE OF DIRECTION, NSG THE NUMBER
C OF ELMNTS CONSIDERED IN MOVING IN EACH DIRECTION.
 40   L=0
 50   L=L+1
      IF(ISD(L).EQ.1)GO TO 70
 60   IF(L.EQ.4)GO TO 300
      NSG=0
      GO TO 50
 70   NSG=NSG+1
      GO TO (80,90,100,110),L
C THE FOUR GROUPS OF STATEMENTS AT 80, 90, 100, AND 110 SELECT THE I AND
C J INDICES FOR THE CANDIDATE TARGET ELMNTS.  TESTS ARE MADE TO PREVENT
C COMPUTING INVALID INDEX VALUES.
```

```
 80    IP=II
       JP=JJ-NSQ
       IF(JP.LT.19)GO TO 60
       GO TO 85
 90    IP=II
       JP=JJ+NSQ
       IF(JP.GT.21)GO TO 60
       GO TO 85
 100   IP=II-NSQ
       JP=JJ
       IF(IP.LT.IMIN(I))GO TO 60
       GO TO 85
 110   IP=II+NSQ
       JP=JJ
       IF(IP.GT.IMAX(I))GO TO 60
C IRET = 3 SIGNALS CONTINUED NEED FOR PERIMETER (LATERAL) CHECKING.
 85    IRET=3
C UNPACK THE STATE DATA ON THE CANDIDATE TARGET ELMNT. ITS PAST AND
C PRESENT STATE MUST BE EQUAL TO QUALIFY FOR TRANSITION.
 122   CALL CVOUT(IP,JP,I,IST,ISTP,ITFCP)
       IF(IST.NE.ISTP)GO TO 160
       CALL CWORD(IWORDS(IS,IP,JP),ITX,ITY)
C SELECT THE STATE TRANSITION BASED ON THE CURRENT STATE: 1 -> 5; 2
C REMAINS 2; SKIP 3, 4, AND 7; 5 -> 2, 6 -> 5.
       GO TO (124,130,160,160,130,125,160),IST
 124   ITX=0
 125   IST=5
       GO TO 140
 130   IF(IST.EQ.2)GO TO 135
       KX=IRAYS(JP)
       IF(ITX.LT.ITPS(KX))GO TO 135
       IST=2
       XTPC=ITPCS(KX)
       IF(XTPC.LE.0.) GO TO 160
       KTEMP=(DELTSP/XTPC)*THOU
       ITFCP=ITFCP+KTEMP
       ITX=ITX-ITPS(KX)
       NPE(I)=NPE(I)+1
C REPACK THE NEW STATE DATA ON THE TARGET ELMNT.
 135   ITY=-1
 140   ISG=1
       IF(ITY.LT.0)ISG=-1
       IWORDS(IS,IP,JP)=ITY*10000+ISG*ITX
       ISTATS(IS,IP,JP)=ITFCP*100+ISTP*10+IST
 160   CONTINUE
C CONTROL REACHES STMT 180 WHEN THE SURFACE OF THE TARGET ELMNTS IS
C A CEILING OR HAT RACK SURFACE. USE ARRAY IARY TO DECIDE WHICH
 180   LL=IONE(IS)+IP
       IDX=12
       IF(IARY(LL,10).GT.0)IDX=10
       IPP=IARY(LL,IDX)
       JPP=JONE(IS)+4
       IF(JP.EQ.22) GO TO 250
       IF(IXFIRE.EQ.2)JPP=JPP+18-JP
       ICRIT=IRAY(IPP)
C TEST TO FIND WHETHER THE FLAMES CONTACT THE TARGET ELMNTS, IF NOT SKIP
C FURTHER CALCULATIONS.
       ZZ=Z(ICRIT)-FHGT
       IF(ZZ.LT.0)GO TO 250
       XTEM=(ZZ*ZZ/(YZ(K)*YZ(K)))*4.0
C COMPUTE THE RADIATION LEVEL FOR THIS OVERHEAD SURFACE.
```

```
      QCS=6.52*(1.-((XTEM-3.)/SQRT((9.+XTEM)*(1.+XTEM))))
      IMT=IMATL(ICRIT)
C TEST THIS RADIATION LEVEL VERSUS THE THRESHOLD LEVEL FOR THE MATERIAL
C OF THE TARGET ELMNTS. IF THE THRESHOLD IS NOT REACHED SKIP OUT.
      IF(QCS.LE.QP(IMT))GO TO 250
C UNPACK THE STATE DATA ON THE TARGET ELMNT.
      CALL CVOUT(IPP,JPP,ICRIT,IST,ISTP,ITFCP)
      IF(IST.NE.ISTP)GO TO 250
      CALL CWORD(IWORD(IPP,JPP),ITX,ITY)
      XTPC=ITPC(ICRIT)
      IF(XTPC.LE.0.) GO TO 250
      ITXX=ITP(ICRIT)
C SELECT THE STATE TRANSITION BASED ON THE CURRENT STATE, SAME RULES
C APPLY AS FOR THE PERIMETER CALCULATIONS.
 210  GO TO(211,215,250,250,215,212,250),IST
 211  ITX=0
 212  IST=5
      GO TO 230
 215  IF(IST.EQ.2)GO TO 220
      IF(ITX.LT.ITXX)GO TO 220
      IST=2
      JTEMP=(DELTSP/XTPC)*THOU
      ITFCP=ITFCP+JTEMP
      ITX=ITX-ITXX
      NPE(ICRIT)=NPE(ICRIT)+1
C REPACK THE TARGET ELMNT STATE DATA.
 220  ITY=-1
 230  ISG=1
      IF(ITY.LT.0)ISG=-1
      IWORD(IPP,JPP)=ITY*10000+ISG*ITX
      ISTATE(IPP,JPP)=ITFCP*100+ISTP*10+IST
C THIS COMPUTED GO-TO SWITCHES CONTROL BACK TO MORE LATERAL (PERIMETER)
C CALCULATIONS AS REQUIRED.
 250  IF(IRET-2)30,300,260
C IF NOT ALL OF THE SMOLDERING RANGE HAS BEEN CONSIDERED RETURN TO 70.
 260  IF(NSQ.LT.NSQH)GO TO 70
      GO TO 60
C END OF THE LOOPS OVER THE SHOOTING ELMNTS.
 300  IF(II.LT.IVMX)GO TO 20
      II=IVMN-1
      IF(JJ.EQ.12)GO TO 500
      IF(JJ.LT.JVMX)GO TO 15
 500  RETURN
      END
```

```
      SUBROUTINE TEST(I)
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) EXAMINE ALL ELEMENTS IN THE FLAMING STATE (STATE 3) ON SURF I TO
C     (A) UPDATE THEIR "FRACTION- CONSUMED" CLOCKS, ITFCP
C     (B) FIND THOSE ELMNTS WHICH ARE NOW DUE TO BURN OUT AND SET
C         THEM TO STATE 4, CHARRED.
C (2) FIND THE TOTAL RATES OF HEAT, SMOKE, AND GAS RELEASE FOR ALL MATLS
C     IN THE FLAMING STATE BY SUMMING THE VALUES FOR EACH SURFACE I.
C COMMENTS
C (1) TEST IS CALLED ONCE FOR EACH FIRE K FOUND ON SURFACE I
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120,15), ISTATS(9,16,22),
     1             IWORD(120,15), IWORDS(9,16,22), NFLM(7), NPYR(7),
     2             RGS(10,7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2,100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20,4), RFS(7,4),
     1             RFWS, RGF(10,7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11,5), CHIU(11,5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40,15), IARY(40,12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9,10), ISSWLJ(9,10), ISSWRI(9,10), ISSWRJ(9,10),
     5             ISWSL(15,8), ISWSR(15,8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20,3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18,7,6), TABY(18,7,6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30,2,4), TSP(2,2,4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      COMMON /PRTCMN/ ASRFUZ(22,4), ASRFLZ(22,4), CVFLWU(22,4),
     *                CVFLWL(22,4), RDFLWU(22,4), RDFLWL(22,4)
     *                VTFLWV(24,2), VTFLWE(24,2), FBVDOT(30),
     *                FBSDOT(11,30), FBGDOT(30), FRENTR(30)
C COMPUTE THE ELMNT AREA, SA, AND SELECT THE MAX AND MIN I AND J VALUES
C FOR THIS FIRE, K.
```

```
      SA=SQD*SQD
      I1=IVMIN(K)
      I2=IVMAX(K)
      J1=JVMIN(K)
      J2=JVMAX(K)
C ITEST IS A FLAG TO INDICATE IF IT HAS BEEN DISCOVERED THAT THE IGN SRC
C FIRE  HAS BURNED OUT. ITEST = 1 => BURNED OUT.
      ITEST=0
C START OF TWO NESTED LOOPS TO SEARCH THE ELMNTS OF THIS FIRE. NOTE THAT
C ALL ELMNTS WITHIN THE "BOX" FORMED BY I1, I2, J1, AND J2 WILL NOT
C NECESSARILY BE IN STATE 3.
      DO 200 II=I1,I2
      DO 190 JJ=J1,J2
C IRET IS A FLAG USED AS FOLLOWS: IRET=1 => ELMNT IN STATE 3 (AND NOT
C JUST IGNITED ON THIS PASS) AND DOES NOT NEED SPECIAL HANDLING BECAUSE
C IT IS AN IGN SRC ELMNT; IRET=2 => AS ABOVE, BUT ELMNT IS PART OF IGN
C SRC FIRE; IRET=3 => ELMNT NOT IN STATE 3.
      IRET=3
      CALL CVOUT(II,JJ,I,IST,ISTP,ITFCP)
C IF ELMNT IS NOT IN STATE 3 OR HAS JUST BEEN SET TO 3 ABOVE, SKIP IT BY
C JUMPING TO END OF LOOP
      IF(IST.NE.ISTP.OR.IST.NE.3) GO TO 190
C IGNFIR=2 => THIS FIRE CONTAINS IGN SRC ELMNTS, I=IGSN => CURRENT SURF
C IS THE ONE CONTAINING THE IGN SRC. IN EITHER CASE CHECK TO SEE IF THIS
C ELMNT IS PART OF THE IGN SRC FIRE BY JUMPING TO STMT 8.
      IF(IGNFIR.EQ.2 .OR. I.EQ.IGSN)GO TO 8
      IRET=1
      GO TO 20
C CHECK THE INDICES OF THIS ELMNT AGAINST THE LIST OF IGN SRC ELMNT
C INDICES. IF A MATCH IS FOUND SET IRET =2 FOR USE BELOW.
 8    DO 10 KJ=1,NIJSG
      IF(II.NE.IGNIJ(1,KJ) .OR. JJ.NE.IGNIJ(2,KJ))GO TO 10
      GO TO 12
 10   CONTINUE
      IF(IGNFIR.NE.2)IRET=1
      GO TO 20
 12   IF(IGNFIR.EQ.2)IRET=2
C TEST IF CURRENT SURF IS A LINING SURF OR A SEAT.. IN EACH CASE,UNPACK
C IWORD(S) TO GET AT ITX, THE TIME-IN-STATE CLOCK.
 20   IF(I.GT.LSN) GO TO 30
      KX=IRAY(II)
      KTEMP=IMATL(KX)
      XTFC=ITFC(KX)
      CALL CWORD(IWORD(II,JJ),ITX,ITY)
      GO TO 40
 30   IS=I-LSN
      KX=IRAYS(JJ)
      KTEMP=IMATS(KX)
      XTFC=ITFCS(KX)
      CALL CWORD(IWORDS(IS,II,JJ),ITX,ITY)
C USE FLAG IRET TO SELECT METHOD OF UPDATING ITX AND TESTING FOR BURN
C OUT. THE DIFFERENCE IS THAT FOR IGN SRC ELMNTS (IRET=2) THE FRACTION-
C CONSUMED, ITFCP, IS FIXED IRRESPECTIVE OF CHANGES IN FLUX LEVEL.
 40   IF(IRET-2)45,120,190
C UPDATE FRACTION-CONSUMED AND TIME-IN-STATE CLOCKS FOR NON-IGN SRC
C ELMNTS.
 45   ITEMP=(DELTSP/XTFC)*THOU
      ITFCP=ITFCP+ITEMP
      IF(ITFCP.GT.1000)GO TO 55
      IDL=DELTSP
      ITX=ITX+IDL
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      GO TO 140
C UPDATE TIME-IN-STATE CLOCK FOR IGN SRC ELMNTS
 120  IDL=DELTSP
      ITX=ITX+IDL
      IF(ITX.LT.ITFCP) GO TO 140
C ELMNT HAS BURNED OUT, SET STATE TO 4, ZERO CLOCKS, AND UPDATE COUNTERS
 55   IST=4
      ITX=0
      ITY=0
      IF(I.GT.LSN) KX=I
      NFE(KX)=NFE(KX)-1
      NCE(KX)=NCE(KX)+1
C TEST IF THIS IS AN IGN SRC ELMNT
      IF(IRET.EQ.2) GO TO 80
C ADJUST THE HEAT, SMOKE, AND GAS RELEASE AND OXYGEN CONSUMPTION RATES
C TO REFLECT THE BURN OUT OF THIS NON-IGN SRC ELMNT.
      DGK=DGK-SA*DGM(KTEMP)
      TDGMTL(KTEMP) = TDGMTL(KTEMP) + GTR * DGM(KTEMP)
      RSFK=RSFK-SA*RSF(KTEMP)
      VITNR=VITNR-SA*DGM(KTEMP)/FOX(KTEMP)
      DO 60 IG=1,NTXG
 60   RGFK(IG)=RGFK(IG)-SA*RGF(IG,KTEMP)
      GO TO 140
C ADJUST THE HEAT, SMOKE, AND GAS RELEASE AND OXYGEN CONSUMPTION RATES
C TO REFLECT THE BURN OUT OF THIS IGN SRC ELMNT.
 80   DGK=DGK-SA*DGI
      RSFK=RSFK-SA*RSI
      VITNR=VITNR-SA*DGI/FOXI
      DO 130 IG=1,NTXG
 130  RGFK(IG)=RGFK(IG)-SA*RTGI(IG)
C SET ITEST = 1 TO SIGNAL THE BURN OUT OF THE ENTIRE IGN SRC FIRE. ONE
C IGN SRC ELMNT IS ENOUGH TO INDICATE THIS SINCE ALL IGN SRC ELMNTS ARE
C ASSUMED TO HAVE THE SAME BURNING TIME
      ITEST=1
C REPACK ISTATE, ISTATS, IWORD, AND IWORDS AS APPROPRIATE FOR SEATS OR
C LINING SURFACES
 140  ITEMP=ITFCP*100+ISTP*10+IST
      ISG=1
      IF(ITY.LT.0) ISG=-1
      IF(I.GT.LSN) GO TO 150
      ISTATE(II,JJ)=ITEMP
      IWORD(II,JJ)=ITY*10000+ISG*ITX
      GO TO 190
 150  ISTATS(IS,II,JJ)=ITEMP
      IWORDS(IS,II,JJ)=ITY*10000+ISG*ITX
C END OF DOUBLE LOOP SEARCHING ELEMENTS OF THE FIRE K.
 190  CONTINUE
 200  CONTINUE
C
C SAVE THE RATE OF GENERATION  OF HEAT AND TRACE SPECIES
C  FOR THIS FIRE K FOR PRINTING IN SUBR OUTPUT
C
      FBQDOT(K) = DGK
      DO 205 IG=1,NTXG
 205  FBSDOT(IG+5,K) = RGFK(IG)
      FBSDOT(NTXG+6,K) = RSFK
      FBSDOT(2,K) = VITNR
C TEST TO FIND IF THE IGN SRC FIRE HAS BURNED OUT. IF SO SET THE FLAG
C IBURN TO ZERO, THE IGN FIRE AREA TO ZERO, AND THE IGN SURF TO A
C HARMLESS NUMBER
      IF(ITEST.EQ.0) GO TO 210
```

```
      IGSN=999
      IBURN=0
      AFI=0.
C UPDATE THE TOTAL HEAT, (FLAMING) SMOKE, AND (FLAMING) GAS RELEASE
C RATES AND OXYGEN CONSUMPTION RATES BY THE CHANGES FOUND IN THIS SUBR
 210  TDQ=TDQ+DQK
      TRSF=TRSF+RSFK
      TOTVIT=TOTVIT+VITNR
      DO 220 IG=1,NTXG
 220  TRGF(IG)=TRGF(IG)+RGFK(IG)
C RESET IGNFIR FLAG TO ZERO. IT WILL BE SET BACK TO 2 IF MORE IGN SRC
C ELMNTS ARE DISCOVERED DURING SUBSEQUENT SEARCHES IN THIS SET OF FLAME
C SPRD CALCS. THIS IS DONE IN SUBR FIRE.
      IF(IGNFIR.EQ.2) IGNFIR=0
      RETURN
      END
```

```
      SUBROUTINE ELEM
C -----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) SCANS ALL LINING AND SEAT SURFACE ELEMENTS TO MAKE APPROPRIATE
C     CHANGES OF STATE FOR ALL TRANSITIONS EXCEPT (A) ELMNTS SET TO
C     STATE 3 (FLAMING) OR STATE 6 (HEATING BY FLAME CONTACT) IN SUBRS
C     COND, CONDS, FCON, AND FCONS; (B) ELMNTS SET TO STATE 2 (SMOLDERING)
C     OR STATE 5 (HEATING BY RADIATION ONLY) BY SUBRS PVOL AND PVOLS;
C     AND (C) FLAMING ELMNTS BURNING OUT (STATE 3 -> STATE 4) DONE IN
C     SUBR TEST.
C (2) UPDATE THE "ELAPSED TIME IN THIS STATE" CLOCK, ITX, FOR THOSE
C     ELMNTS IN STATES WHERE THIS TIME IS KEPT (STATES 2, 5, AND 6).
C (3) UPDATE THE "FRACTION CONSUMED" CLOCK, ITFPC, FOR ELMNTS
C     IN STATE 2.
C COMMENTS
C (1) THE INCREMENT OF ITX IS THE LARGE TIME STEP, I.E. THE TIME BETWEEN
C     PASSES THRU THE FLAME SPREAD CALCS.
C (2) THIS SUBR HAS A VERY COMPLICATED TRANSFER STRUCTURE, CAREFUL
C     ATTENTION SHOULD BE PAID TO THE COMMENTS. RE-CODING IS ADVISED.
C (3) POSSIBLE STATE TRANSITIONS THAT MAY OCCUR ARE: 5 -> 1, 2 -> 4,
C     2 -> 7, AND 7 -> 4.
C -----------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DQI, DQM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), QCI, QP(7), QTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
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AD-A118 390 DAYTON UNIV OH RESEARCH INST F/G 1/2
DAYTON AIRCRAFT CABIN FIRE MODEL, VERSION 3. VOLUME II. PROGRAM--ETC(U)
JUN 82 C D MACARTHUR DOT-FA74WA-3532
UNCLASSIFIED UDRI-TR-81-160-VOL-2 DOT/FAA/CT-81/69-2 NL

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     5              XMFI, TKNS(7), TSL(30,2,4), TSP(2,2,4), CPM(7), WMMTL(7),
     6              WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
C SET ITM TO THE LARGE TIME STEP IN SECONDS (NOT MILLISECONDS)
C ITYP IS A FLAG TO INDICATE WHETHER LINING SURFS OR SEATS ARE BEING
C CONSIDERED. ITYP =1 => LINING SURFS.
      ITM=ITSPRD/1000
      I=0
      ITYP=1
C STMTS 10 THRU 40 FORM A LOOP TO SEARCH OVER ALL LINING SURFACE ELMNTS.
C THE ELEMENT STATES, FLAGS, AND CLOCKS ARE UNPACKED WITH SUBRS CVOUT
C AND CWORD. WHEN THESE VALUES ARE FOUND TRANSFER GOES TO STMT 100 FOR
C CLOCK AND FLAG UPDATING AND ANY NECESSARY STATE TRANSITIONS. CONTROL
C IS RETURNED INTO THE LOOP AT STMT 20.
C IEXTG KEEPS THE APPROPRIATE VALUE OF ITPE(I), THE TIME TO STOP
C PYROLYSIS FOR THE MATERIAL OF SURFACE I, WHICH WILL BE USED FOR 7->4
C TRANSITIONS
 10   I=I+1
      IF(I.GT.LSN) GOTO 50
      I1=IMIN(I)
      I2=IMAX(I)
      J1=1
      J2=15
      IEXTG=ITPE(I)
      DO 40 II=I1,I2
      DO 30 J=J1,J2
      CALL CVOUT(II,J,I,IST,ISTP,ITFCP)
      CALL CWORD(IWORD(II,J),ITX,ITY)
      GOTO 100
20    CONTINUE
30    CONTINUE
40    CONTINUE
      GOTO 90
C STMTS 50 THRU 80 FORM A LOOP TO SEARCH OVER ALL SEAT SURFACE ELMNTS,
C UNPACK THE DATA, AND TRANSFER TO 100 AS EXPLAINED ABOVE. IEXTG NOW
C HOLDS THE APPROPRIATE VALUE OF ITPES(I)
50    ITYP=2
      IS=I-LSN
      I1=IMIN(I)
      I2=IMAX(I)
      J1=1
      J2=22
      DO 80 J=J1,J2
      JK=IRAYS(J)
      IEXTG=ITPES(JK)
      DO 70 II=I1,I2
      CALL CVOUT(II,J,I,IST,ISTP,ITFCP)
      CALL CWORD(IWORDS(IS,II,J),ITX,ITY)
      GOTO 100
60    CONTINUE
70    CONTINUE
80    CONTINUE
C TEST TO FIND IF ALL SURFACES HAVE BEEN EXAMINED.
90    IF(I.LT.NS) GOTO 10
      GOTO 500
C THE FOLLOWING STMT SEPARATES ELMNT TYPES 1,3,AND 4 FROM 2,5,6,AND 7.
C TRANSITIONS FOR TYPES 1,3,AND 4 ARE NOT CONSIDERED BY THIS SUBR
 100  GO TO (220,101,220,220,101,101,101),IST
 101  CONTINUE
C IF THE PRESENT STATE AND PREVIOUS STATE ARE EQUAL TRANSITIONS ARE
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C ALLOWED, OTHERWISE ONLY CLOCK AND FLAG UPDATING IS ALLOWED.
 102  IF(IST.EQ.ISTP) GO TO 120
C ELEMENTS SET TO STATE 7 IN THE LAST FLAME SPREAD PASS ARE SKIPPED
      IF(IST.EQ.7) GO TO 220
C UPDATE THE ITX CLOCK FOR ELMNTS OF TYPES 2,5, AND 6 HAVING ISTP.NE.IST
 110  ITX=ITX+ITM
C IF PRESENT STATE IS 6 REPACK IMMEDIATELY, IF IT IS 2 OR 5 SET ITY=+1
C (FORCES 5->1 OR 2->7 TRANSITION ON NEXT PASS IF NOT RESET IN PVOL OR
C  PVOLS) AND THEN REPACK
      IF(IST.EQ.6) GO TO 210
      ITY=+1
      GO TO 210
C CONTROL REACHES THE FOLLOWING STMT ONLY FOR ELMNTS IN STATES 2,5,6,
C AND 7 WITH ISTP = IST. DISPOSITION IS AS SHOWN
C     STATE 2 -> GO TO 140  TO CHECK FOR POSSIBLE TRANSITION TO 7
C     STATE 5 -> GO TO 140  TO CHECK FOR POSSIBLE TRANSITION TO 1
C     STATE 6 -> GO TO 110  FOR UPDATE OF ITX AND REPACK
C     STATE 7 -> GO TO 122  TO CHECK FOR POSSIBLE TRANSITION TO 4
 120  GO TO (122,140,122,122,140,110,122),IST
 122  ITX=ITX+ITM
      ITEST=IEXTG
      GO TO 170
C ITY .LE. ZERO INDICATES THAT THE ELMNT SHOULD NOT TRANSITION THIS PASS
 140  IF(ITY.LE.0) GO TO 160
C ITY .GT. ZERO INDICATES TRANSITION TO 5->1 OR 2->7 IS TO BE MADE NOW
      ITX=0
      ITY=0
      IF(IST.EQ.2) GO TO 150
      IST=1
      GO TO 210
 150  IST=7
      GO TO 210
C UPDATE ITX, SET ITY TO +1 TO NOMINATE THIS ELMNT FOR TRANSITION ON THE
C NEXT PASS, AND IF THE PRESENT STATE IS NOT 2 GO TO 210 FOR REPACKING
 160  ITX=ITX+ITM
      ITY=1
C FOR STATE 2 UPDATE ITFPC AND CHECK TO SEE IF THIS "FRACTION CONSUMED"
C X1000 EXCEEDS 1000. IF SO TRANSITION TO STATE 4, CHARRED. ITYP = 2
C INDICATES THAT ELMNT IS FROM A SEAT GROUP
      IF(IST.NE.2) GO TO 210
      IF(ITYP.EQ.2) GO TO 162
      XTPC=ITPC(I)
      GO TO 165
 162  XTPC=ITPCS(JK)
 165  KTEMP=(DELTSP/XTPC)*THOU
      ITFCP=ITFCP+KTEMP
      IF(ITFCP.LE.1000) GO TO 210
      GO TO 175
C CONTROL REACHES STMT 170 ONLY IF THE ELMNT IS IN STATE 7
C TEST TO FIND IF TRANSITION TO STATE 4 SHOULD NOW OCCUR BY COMPARING
C ITX TO THE TIME TO STOP PYROLYZING KEPT IN ITEST
 170  IF(ITX.LT.ITEST) GO TO 210
C MAKE THE 2->4 TRANSITION OR THE 7->4 TRANSITION, DEPENDING ON HOW STMT
C 175 IS REACHED. NPE(I), THE NUMBER OF PYROLYZING ELMNTS ON SURF I, IS
C DECREASED BY 1, AND NCE(I), THE NUMBER OF CHARRED ELMNTS ON I, IS
C INCREASED BY 1.
 175  NPE(I)=NPE(I)-1
 190  IST=4
      NCE(I)=NCE(I)+1
      ITX=0
      ITY=0
```

```
C THE NEXT 10 STMTS REPACK ISTATE AND IWORD OR ISTATS AND IWORDS WITH
C THE NEW ELMNT DATA.  ISG USED TO MAKE SIGN OF ITX COMPATIBLE WITH ITY.
 210  ITEMP=ITFCP*100+ISTP*10+IST
      ISG=1
      IF(ITY.LT.0) ISG=-1
      ITK=ITY*10000+ISG*ITX
      IF(ITYP.EQ.2) GO TO 215
      ISTATE(II,J)=ITEMP
      IWORD(II,J)=ITK
      GO TO 220
 215  ISTATS(IS,II,J)=ITEMP
      IWORDS(IS,II,J)=ITK
C STMT 220 DIRECTS CONTROL BACK TO THE LOOP SEARCHING LINING SURFS OR
C SEATS AS DETERMINED BY ITYP:  ITYP=1 => LINING SURF,  =2 => SEAT.
  220 IF(ITYP-1) 60,20,60
C
 500  CONTINUE
      RETURN
      END
```

```
      SUBROUTINE AFP
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) COMPUTE TOTAL AREAS OF EACH MATERIAL CURRENTLY FLAMING, SMOLDERING
C     AND CHARRED.
C (2) COMPUTE TOTAL RATE OF SMOKE EMISSION BY ALL MATERIALS (SMLDRG
C     AND FLAMING) AND TOTAL RATE OF EMISSION OF EACH GAS BY ALL MATLS
C     (SMLDRNG AND FLAMING)
C COMMENTS
C (1) RATES OF SMOKE AND GAS EMISSION FOR FLAMING MATERIALS (BY MATL
C     TYPE) IS COMPUTED UPSTREAM BY SUBR TEST AND ADDED TO THE SMLDRG
C     RATES COMPUTED HERE.
C ---------------------------------------------------------------------
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCJSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 13), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
      DIMENSION NCM(7)
C SET COUNTERS FOR THE NUMBER OF FLAMING, SMLDRG, AND CHARRED ELMNTS
C TO ZERO.  INDEXES ARE MATERIAL NUMBER
      DO 10 M=1,NMATLS
      NFLM(M)=0
```

```
      NCM(M)=0
 10   NPYR(M)=0
C SEARCH THE LINING SURFACES FOR ELMNTS SMLDRG (STATE =2 OR 7), FLAMING
C (STATE =3), OR CHARRED (STATE = 4) AND COUNT THE NUMBER OF EACH.
C MATERIAL TYPE OF EACH SURF IS DETERMINED BY ARRAY IMATL(SURF NO).
      ITOTAL =IMAX(LSN)
      DO 30 I=1,ITOTAL
      IX=IRAY(I)
      JX=IMATL(IX)
      DO 20 J=1,15
      CALL CVOUT(I,J,IX,IST,I1,I2)
      IF(IST.NE.2. .OR. IST.NE.7) GO TO 15
      NPYR(JX)=NPYR(JX)+1
      GO TO 20
 15   IF(IST.NE.3) GO TO 17
      NFLM(JX)=NFLM(JX)+1
 17   IF(IST.NE.4) GO TO 20
      NCM(JX)=NCM(JX)+1
 20   CONTINUE
 30   CONTINUE
C SEARCH EACH SEAT GROUP FOR ELMNTS IN STATES 2,3,4, OR 7 AND ADD THE
C COUNTS IN EACH STATE TO THOSE FOUND ABOVE. SEAT SURFACE IS IDENTIFIED
C USING ARRAY IRAYS AND SURFACE MATERIAL BY ARRAY IMATS.
      IT=LSN+1
      DO 70 KK=IT,NS
      I1=IMIN(KK)
      I2=IMAX(KK)
      DO 60 J=1,22
      JK=IRAYS(J)
      IX=IMATS(JK)
      DO 50 I=I1,I2
      CALL CVOUT(I,J,KK,IST,ISTP,ITFCP)
      IF(IST.NE.2. .OR. IST.NE.7) GO TO 40
      NPYR(IX)=NPYR(IX)+1
      GO TO 50
 40   IF(IST.NE.3) GO TO 45
      NFLM(IX)=NFLM(IX)+1
 45   IF(IST.NE.4) GO TO 50
      NCM(IX)=NCM(IX)+1
 50   CONTINUE
 60   CONTINUE
 70   CONTINUE
C COMPUTE AREAS IN EACH STATE BY MULTIPLYING NUMBER OF ELMNTS BY THE
C ELMNT AREA. AREAS ARE REPORTED IN SUBR OUTPUT
      DO 80 M=1,NMATLS
      T1=NFLM(M)
      T2=NPYR(M)
      AFM(M)=T1*SGD*SGD
      ACM(M)=NCM(M)*SGD*SGD
 80   ASM(M)=T2*SGD*SGD
C SUM OVER ALL MATL TYPES THE RATES OF SMOKE AND GAS EMISSION FOR
C SMOLDERING ELMNTS. FIRST SET THE SUMMATION VARIABLES TO ZERO.
 105  TRSS=0.
      DO 110 IG=1,NTXG
 110  TRGS(IG)=0.
C THEN SUM OVER THE NUMBER OF MATERIALS.
      DO 120 IM=1,NMATLS
      XXM=NPYR(IM)
      TRSS=TRSS+QTR*XXM*RSS(IM)
      DO 115 IG=1,NTXG
 115  TRGS(IG)=TRGS(IG)+QTR*XXM*RGS(IG,IM)
```

```
 120  CONTINUE
C ADD THE TOTAL SMOKE AND GAS SMLDRG EMISSION RATES TO THE RATES FOR
C FLAMING EMISSION FOUND IN SUBR TEST.
      TOTSEM=TRSF+TRSS
      DO 125 IG=1,NTXG
 125  TOTGAS(IG)=TRGF(IG)+TRGS(IG)
C
      XX = 0.
      DO 127 IM=1,NMATLS
 127  XX = XX + TDGMTL(IM) / ( WMMTL(IM) * GTAB(IM) )
      XX = XX + ( IBURN * DGI * AFI ) / ( WMIGF * GCI )
C
C
C
      GENRAT(1) = 0.
      GENRAT(2) = -TOTVIT
      GENRAT(3) = 0.
      GENRAT(4) = 44. * XX
      GENRAT(5) = 18. * XX
C
      DO 130 IG=1,NTXG
      GENRAT(5+IG) = TOTGAS(IG)
 130  CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE RESET
C
      COMMON/CNTRL/DELTAT, DELTSP, ECOFLG, IDELT, IDENT(20), IDTPRV, IPEMS,
     1             IPSPR, IPAUX, IRATIO, ISAVE, ISCALE, ITFIN, ITIME, ITIM2,
     2             ITSPRD, NPASS, TFINAL, IDBUG1, EPSLN, MAXITR, MAXCUT,
     3             JCBSKP
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1             IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2             RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3             TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4             ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5             FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6             IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7             IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8             JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9             NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1             RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2             TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3             FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4             TP(7), TPC(7)
      COMMON/GASES/CHIL(11, 5), CHIU(11, 5), CP, NGAS(11), NSPCS, PAMB, PF(5),
     1             RHOAM, RHOL(5), RHOU(5), TAM, TL(5), TU(5), VOLL(5),
     2             VOLU(5), ZD(5), XTHEN(120), WMOLEC(11), TWO(101),
     3             JCOR(120)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1             IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2             CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3             ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4             ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5             ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6             IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7             SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8             XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9             HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1             CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2             FHMIN
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1             FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2             ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3             ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4             RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5             XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6             WMIGF, TKNSIN(7)
      COMMON/PARAMS/GRAV, PI, GTR, RGAS, SIGMA, SGD, THOU, TOL, EC, EP
      COMMON/RADTN/ALPC, ABSCF(30), EB, GC(2)
C ------------------------------------------------------------------------
C OBJECTIVE(S)
C (1) EXAMINES THE CURRENT STATE OF ALL ELEMENTS, IST, AND THE PREVIOUS
C     STATE, ISTP, (PREVIOUS STATE IS THE STATE JUST BEFORE THE START
C     OF THE LAST FLAME SPREAD CALCULATIONS.) IF THE TWO STATES ARE NOT
C     THE SAME RESET CHANGES ISTP TO IST IN PREPARATION FOR THE NEXT
C     PASS THRU THE FLAME SPREAD CALCS.
C ------------------------------------------------------------------------
C PART ONE - EXAMINE ALL ELEMENTS ON CABIN LINING SURFACES
C LOOP OVER ALL VALUES OF THE I INDEX
      I=0
 10   I=I+1
C LOOP OVER ALL VALUES OF THE J INDEX
      J=0
 20   J=J+1
      CALL CVOUT(I, J, 1, IST, ISTP, ITFCP)
```

```
C IF ISTP IS NOT = IST, SET ISTP = IST AND REPACK ISTATE
      IF(IST.EQ.ISTP) GO TO 30
      ISTP=IST
      ISTATE(I,J)=ITFCP*100+ISTP*10+IST
 30   IF(J.LT.JMAX(I)) GO TO 20
      IF(I.LT.MAXELI) GO TO 10
C PART TWO - EXAMINE ALL ELEMENTS ON SEAT SURFACES
C IS = THE SEAT GROUP NUMBER (1,2,3,...) AND I=IS+LSN
C LOOP OVER THE SEAT II INDEX
      I=LSN
 40   I=I+1
      IS=I-LSN
C LOOP OVER THE SEAT JJ INDEX
      JJ=0
 50   JJ=JJ+1
      II=0
 60   II=II+1
      CALL CVOUT(II,JJ,I,IST,ISTP,ITFCP)
C IF ISTP IS NOT = IST, SET ISTP = IST AND REPACK ISTATS
      IF(ISTP.EQ.IST) GO TO 70
      ISTP=IST
      ISTATS(IS,II,JJ)=ITFCP*100+ISTP*10+IST
 70   IF(II.LT.IMAX(I)) GO TO 60
      IF(JJ.LT.JMAX(I)) GO TO 50
      IF(I.LT.NS) GO TO 40
C
      RETURN
      END
```

```
      SUBROUTINE ISIDE(IFF,ISD)
C ------------------------------------------------------------------
C OBJECTIVE(S)
C (1) UNPACKS DATA FROM ARRAY 'IF' TO DETERMINE WHICH ELEMENTS, IF ANY,
C     ADJOINING A GIVEN FLAMING ELEMENT ARE ALSO FLAMING. F.P. 'IFF'
C     IS THE VALUE OF IF.  ARRAY ISD(L) IS RETURNED WITH
C        ISD(L) =0 IF SIDE L ADJOINS ANOTHER FLAMING ELEMENT
C        ISD(L) =1  IF SIDE L DOES NOT => IS ON EDGE OF A FIRE
C     NUMBERING OF SIDES IS AS SHOWN
C
C                      L=2
C                    XXXXXXX     --> I INCREASING
C                    X     X
C                 L=3X     XL=4   ^
C                    X     X      !  J INCREASING
C                    XXXXXXX      !
C                      L=1
C ------------------------------------------------------------------
      DIMENSION ISD(4)
C
      IT1=IFF-(IFF/10)*10
      IT=IFF-IT1
      IT2=IT-(IT/100)*100
      IT=IFF-IT2-IT1
      IT3=IT-(IT/1000)*1000
      ISD(4)=IFF/1000
      ISD(1)=0
      IF(IT1.GT.1) ISD(1)=1
      ISD(2)=IT2/10
      ISD(3)=IT3/100
      RETURN
      END
```

```
      SUBROUTINE CVOUT(II, JJ, I, IST, ISTP, ITFCP)
      COMMON/FIRES/AFM(7), ASM(7), ISTATE(120, 15), ISTATS(9, 16, 22),
     1              IWORD(120, 15), IWORDS(9, 16, 22), NFLM(7), NPYR(7),
     2              RGS(10, 7), RSS(7), TOTGAS(10), TOTSEM, TRGF(10),
     3              TRGS(10), TRSF, TRSS, NCE(30), VITNR, TOTVIT, RADFIR(30),
     4              ACM(7), AF(30), AFI, AEXP, COMB(30), DGK, FLML(30), FSN1,
     5              FSN2, FSN3, GAMMA(30), IBURN, IF(600), IGMNI, IGMNJ, IGMXI,
     6              IGMXJ, IGNFIR, IGNIJ(2, 100), IGSN, ISFIRE(30), IVMAX(30),
     7              IVMIN(30), IVMN, IVMX, IXFIRE, IZONE(30), JVMAX(30),
     8              JVMIN(30), JVMN, JVMX, K, NFE(30), NFIRES, NIJC, NIJSG,
     9              NPE(30), NSFL(7), OMEGA(30), PDH, PIGN, RF(20, 4), RFS(7, 4),
     1              RFWS, RGF(10, 7), RGFK(10), RHOZ(30), RSF(7), RSFK, TDG,
     2              TBURNI, UZ(30), YZ(30), ZB(30), RHOEFG, CHIEFG(11),
     3              FLOWIN, FLWOUT, TEFG, IFRVNT, GENRAT(11), TDGMTL(7),
     4              TP(7), TPC(7)
      COMMON/GMTRY/IMATL(20), IMATS(7), IMTLP(4), IMAX(30), IMIN(30),
     1              IRAY(116), IRAYS(22), JMAX(30), JMIN(30), LSN, MAXELI, NS,
     2              CH, CL(4), CW, DWS, HSTS, IARX(40, 15), IARY(40, 12), ICLL,
     3              ICLR, IEND, IFIRL, IFIRR, ILSTL, ILSTR, IONE(9),
     4              ISSWLI(9, 10), ISSWLJ(9, 10), ISSWRI(9, 10), ISSWRJ(9, 10),
     5              ISWSL(15, 8), ISWSR(15, 8), ISTART, NPROJ, IPJUL, IPJLL,
     6              IPJUR, IPJLR, JEND, JONE(9), JSTART, NJS, NSG, NV, SGWD(9),
     7              SL, SWD(20), VN(20, 3), VENTH(24), VENTW(24), VENTT(24),
     8              XMN(30), XMX(30), XCOR(9), YCOR(9), Z(30), SSGWD, TVSG,
     9              HT1, HT2, HT3, HT4(10), NSSTS, SLSW, SX(30), SZ(30),
     1              CNCTNS(24), NCOMPS, IFRCMP, FLOW(24), INTO(24), VTOTAL(4),
     2              FHMIN
C ----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) TO UNPACK ISTATE AND ISTATS. F.P.  'I' IS THE SURFACE NUMBER,
C      'II,JJ' ARE THE ELEMENT INDICES
C COMMENTS
C (1) WHEN DEALING WITH SEAT ELMNTS 'IS' IS THE SEAT GROUP NUMBER
C ----------------------------------------------------------------------
      IF(I.GT.LSN) GO TO 10
      ITEMP=ISTATE(II, JJ)
      GO TO 20
 10   IS=I-LSN
      ITEMP=ISTATS(IS, II, JJ)
C
 20   IST=ITEMP-(ITEMP/10)*10
      IT=ITEMP-IST
      ISTP=(IT-(IT/100)*100)/10
      ITFCP=ITEMP/100
      RETURN
      END
```

```
      SUBROUTINE CWORD(IX,ITX,ITY)
C ----------------------------------------------------------------------
C OBJECTIVE(S)
C (1) UNPACKS DATA IN IWORD AND IWORDS, RETURNING VALUES OF ITX AND ITY
C
C ----------------------------------------------------------------------
C
      IF(IX.LT.0) GO TO 10
C
      ISG=1
      ITEMP=IX
      GO TO 20
C
 10   ISG=-1
      ITEMP=-IX
C
 20   ITX=ITEMP-(ITEMP/10000)*10000
      ITY=(IX-ISG*ITX)/10000
C
      RETURN
      END
```

```
      SUBROUTINE LINT(NO, X, M, Y)
      COMMON/MATLS/TABX(18, 7, 6), TABY(18, 7, 6), NTXG, FOXI, RADTAB(7), RADI,
     1                FOX(7), NMATLS, DGI, DGM(7), GAMI, GTAB(7), ITF(20), IRAMPT,
     2                ITFC(20), ITFCS(7), ITFS(7), ITP(20), ITPC(20), ITPCS(7),
     3                ITPE(20), ITPES(7), ITPS(7), GCI, GP(7), GTAB(7), RHOI,
     4                RHOM(7), RSI, RTAB(7), RTGI(10), UTAB(7), CNDCTY(7), XMUI,
     5                XMFI, TKNS(7), TSL(30, 2, 4), TSP(2, 2, 4), CPM(7), WMMTL(7),
     6                WMIGF, TKNSIN(7)
C ---------------------------------------------------------------------
C OBJECTIVE(S)
C (1) PROVIDE LINEAR INTERPOLATION IN TABLE OF MATERIALS DATA FOR
C     VALUES OF RADIATION LEVEL SUPPLIED AS F.P. 'X'.  F.P. 'NO'
C     IS THE DATA ITEM TYPE, 'M' IS THE MATL NUMBER, AND 'Y' IS
C     THE INTERPOLATED DATA VALUE RETURNED.
C COMMENTS
C (1) IF RADIATION VALUE IS LESS THAN THE FIRST VALUE OF THE
C     PROPERTY IN THE TABLE, THIS FIRST VALUE IS RETURNED. IF THE
C     RADIATION IS GREATER THAN THE LAST VALUE, LINEAR EXTRAPOLATION IS
C     USED TO FIND THE RETURNED PROPERTY VALUE.
C (2) THIS SUBR. ASSUMES SIX ENTRIES IN EACH TABLE.
C ---------------------------------------------------------------------
      MAX=6
      L=0
      I=1
      IF(X.GE.TABX(NO, M, I)) GO TO 20
C RADIATION LEVEL IS LESS THAN THE LOWEST ENTRY IN THE RAD TABLE
 10   Y=TABY(NO, M, I)
      GO TO 70
C
 20   IF(X-TABX(NO, M, I)) 50, 10, 30
 30   IF(I.GE.MAX) GO TO 40
      I=I+1
      GO TO 20
C
 40   L=1
C
 50   S=(TABY(NO, M, I)-TABY(NO, M, I-1))/(TABX(NO, M, I)-TABX(NO, M, I-1))
      IF(L.GT.0) GO TO 60
      Y=S*(X-TABX(NO, M, I-1))+TABY(NO, M, I-1)
      GO TO 70
C RADIATION LEVEL IS HIGHER THAN THE HIGHEST ENTRY IN THE RAD TABLE
 60   Y=S*(X-TABX(NO, M, I))+TABY(NO, M, I)
C
 70   RETURN
      END
```

```
      SUBROUTINE ERROR(NO)
C
C ------------------------------------------------------------------
C OBJECTIVE(S)
C (1) PROVIDE ERROR CHECKING MESSAGES FOR CABIN GEOMETRY INPUT DATA
C COMMENTS
C (1) VALUE OF F.P. 'NO' SUPPLIED BY SUBR. RDGMTY IDENTIFIES ERROR TYPE
C ------------------------------------------------------------------
      WRITE(6,5)


 5    FORMAT(1H1/5X,37H**PROGRAM TERMINATION---INPUT ERROR**)
      GO TO(10,20,30,40,50),NO
C
 10   WRITE(6,15)
 15   FORMAT(5X,21HMORE THAN 20 SURFACES)
      GO TO 100
C
 20   WRITE(6,25)
 25   FORMAT(5X,23HMORE THAN 9 SEAT GROUPS)
      GO TO 100
C
 30   WRITE(6,35)
 35   FORMAT(5X,26HCEILING SURFACES--SEQUENCE)
      GO TO 100
C
 40   WRITE(6,45)
 45   FORMAT(5X,17HNO OF ELEM GT 120)
C
 50   WRITE(6,55)
 55   FORMAT(5X,26HNO OF ELEM ON FLOOR GT 600)
C
 100  RETURN
      END
```

APPENDIX B

EXPRESSIONS FOR SEVERAL QUANTITIES USED IN THE MODELING OF INTERIOR FIRES

Equation (4-13) of Volume I gives the rate of entrainment of lower zone gases into the plume region of an interior fire. The expression contains the quantities y_s, u_s, and ρ_s which are, respectively, the fire column radius, gas velocity, and gas density at the top of the combustion zone. These quantities can, in turn, be written in terms of the characteristics of the fuel vapor at the fire base: ΔH_c, the effective heat of combustion of the fuel vapor; γ, the stoichiometric oxygen-to-fuel mass ratio; ρ_o the fuel vapor density; and u_o the fuel vapor "blowing" velocity at the fire base plane. In addition the expressions for y_s, etc. involve the quantity ω which is computed using the lower zone temperature, T_ℓ^i, and oxygen mass fraction $X_{\ell O_2}^i$, and the radius of the fire base, y_o.

With the above definitions of symbols, the expressions for ω, y_s, u_s, and ρ_s are:

$$\omega = \gamma C_p T_\ell^i / (\gamma C_p T_\ell^i + X_{\ell O_2}^i \Delta H_c) \qquad \text{(B-1)}$$

$$y_s = 1.19 y_o E_c^{1/5} [\omega^3 (1-\omega)]^{-1/10} \qquad \text{(B-2)}$$

$$\cdot \left[(1 + \gamma / X_{\omega O_2}^i)^5 / (\omega \rho_\ell / \rho_o + \gamma / X_{\omega O_2}^i) \right]^{1/10}$$

$$\cdot \left[\rho_o u_o / (\rho_\ell \ g y_o) \right]^{2/5}$$

$$u_s = u_o (y_o / y_s)^2 \left[1 + (\gamma / X_{\ell O_2}^i) / (\omega \rho_\ell / \rho_o) \right] \qquad \text{(B-3)}$$

$$\rho_s = \rho_\ell \omega (1 + \gamma / X_{\ell O_2}^i) / (\omega \rho_\ell / \rho_o + \gamma / X_{\ell O_2}^i) \qquad \text{(B-4)}$$

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